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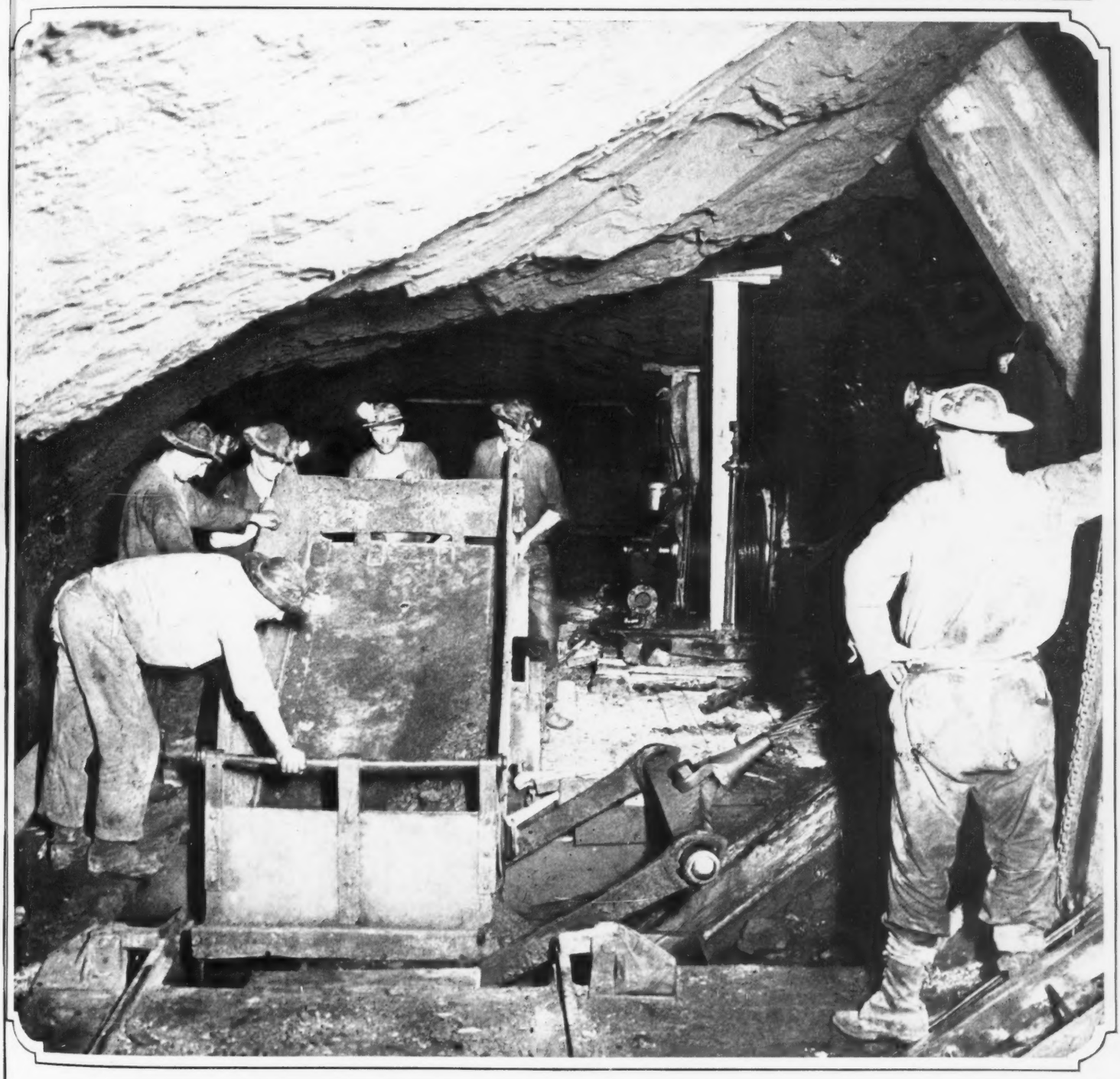

Reduction of Tin Ore With Hydrogen, by C. G. Fink and C. L. Mantell

Automatic Switchboard Equipment for Reclosing and Sectionalizing, by A. E. Anderson

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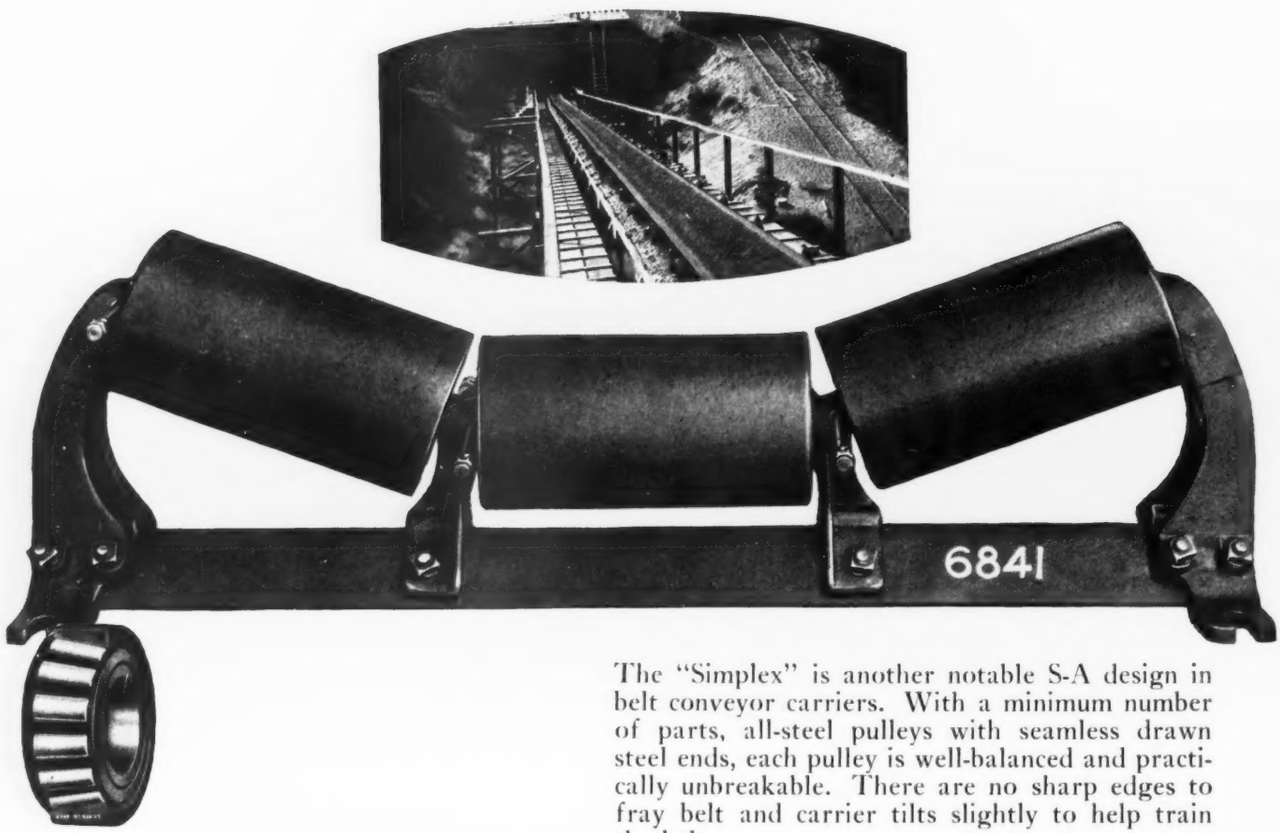

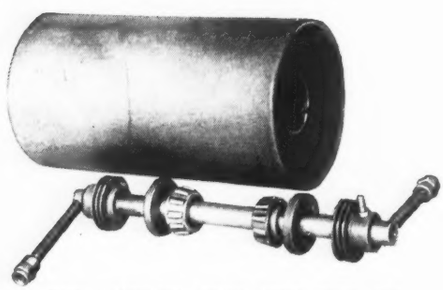

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ENGINEERING AND MINING JOURNAL

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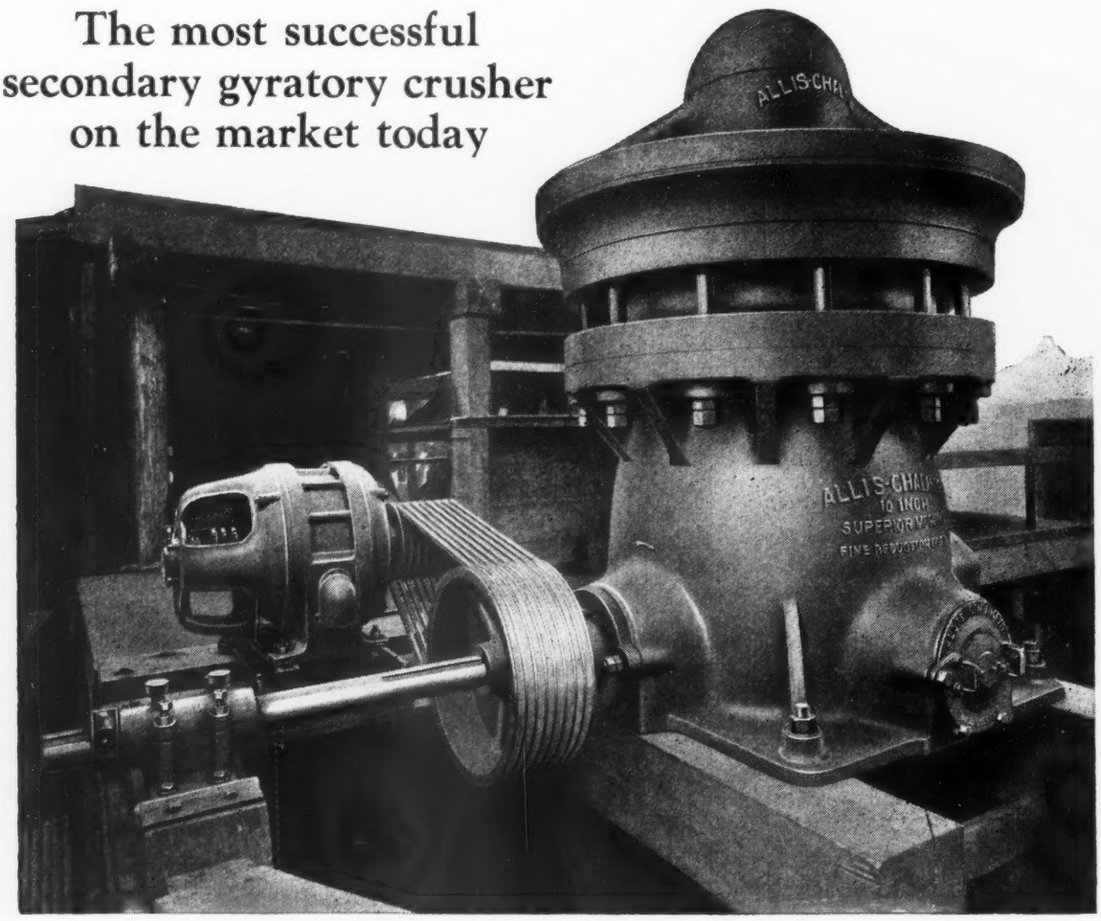

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Size of Crusher in Inches	Two Feed Openings, Size Each in Inches	Capacity Per Hour in Tons of 2,000 Pounds — Size of Discharge Opening in Inches												Driving Pulley		H.P. Required	Weight of Crusher in Pounds
		¾	⅞	1	1¼	1½	1¾	2	2¼	2½	3	3½	4	Size in Inches	R.P.M.		
6	6x40	24	28	32	40	48								36x12½	500	40 50	32,000
10	10x52					80	94	107	120	135				36x19	450	75 100	64,000
18	18x68									250	300	350	400	44x25	400	150 200	182,000

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ENGINEERING AND
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McGraw-Hill Publishing Company, Inc.
JAMES H. MCGRAW, *President*

A. W. ALLEN,
Editor

VOLUME 124 — *New York, December 17, 1927* — NUMBER 25

American Gold to London

SEVEN YEARS AGO the pound sterling was worth only $3.20 in terms of the American dollar. Two years ago it rose to parity with Mr. Winston Churchill's announcement that British paper money was redeemable at is full face value in terms of gold. At that time, however, there was some doubt as to whether or no the pound could yet stand alone, so a credit of $300,000,000 was provided in New York to be used if needed. Now, so high has sterling exchange become that a million dollars in gold has actually been shipped to London by the International Acceptance Bank in New York, the first shipment of such a character that has been made since 1914, before which time shipments of gold between the two countries occasioned no comment.

This is no place to go into the reasons why sterling exchange has risen to the gold-shipment point, for international financing is a most complex matter. In fact, it seems probably that the transfer was more a matter of sentiment than business, for even with the reduction of the freight rate on gold from $\frac{3}{8}$ to $\frac{1}{4}$ per cent of its value, the actual transfer of the metal would apparently not be a profitable operation with sterling selling under $4.88\frac{3}{4}$. But the incident is one of the signposts of a return to the sound international financial structure that obtained before the war and another evidence that the United States is not to be a perpetual sinkhole for the world's gold, as is India for silver. With some four and a half billions of dollars in gold on this side of the Atlantic, recent exports of the metal to England, the Argentine, Brazil, and Canada are comparatively insignificant.

Fruits of an Alliance With an Unscrupulous Promoter

SINCE commenting in our last issue on the appointment of a receiver for the Idaho Copper Company, we have received copies of the complaint and answer in the case. Though the Boise Association of Credit Men is the nominal plaintiff, it is clear from the legal documents that the real quarrel is between Messrs. Cooley Butler, O. H. Driggs, and R. H. Johnson on one side, and George Graham Rice, represented by Walter Harvey Weed and three other Rice men on the board of directors of the Idaho Copper Company, on the other side. No sooner have the legal preliminaries been disposed of in the complaint, than these two opposing groups are mentioned and designated as the Rice and Butler factions. The importance of the matter lies in the fact that it places officially on record the results of an alliance entered into by men of good reputation who were looking for money with which to develop a mining property of some merit, with a notorious promoter, who has been prosecuted repeatedly and convicted several times for swindles of various kinds. Mr. Butler and his associates did not go into this project with Rice unknowingly. They knew Rice's reputation and were warned to have no dealings with him. In spite of this they agreed in 1926 to a merger of their Idaho Copper Company with his Idaho Copper Corporation, attempting to justify themselves on the ground that by so doing they would be able to finance the development of their own mining property. They knew that Rice's property was of little or no value. The following facts and allegations appear from the papers recently filed.

1. That Rice was authorized to name four of the seven directors of the merged company.

2. That the stock of the Butler faction, amounting to slightly less than one-half of the total, was escrowed and withheld from the market for a period of three years from April 7, 1926.

3. That in violation of the contract under which the merger was arranged, instead of using the money paid into the treasury for the "development of the properties" Rice, "over the protest of the Butler faction authorized, sanctioned and caused to be expended sums in excess of $75,000 in drilling and prospecting certain properties of the defendant (the company) with the design, intent, and purpose of allowing and permitting the said Rice to publish favorable comment in what is known as the *Wall Street Iconoclast* . . . whereby the stock acquired by the said Rice . . . would advance and fluctuate in value so as to demand a favorable price upon the Boston Curb Exchange . . . ; that the said funds have been diverted and used to such an extent that the finances of the defendant are now greatly depleted, hindering and impeding its progress, causing it in the main to cease its operations to the extent that it now has outstanding, due, and owing obligations to the extent of $40,000."

4. That minutes of meetings have been prepared that incorrectly record the transactions of the directors, the purpose being to promote the schemes of Rice to the detriment and disadvantage of the company; that Rice refused to furnish the Butler faction with lists showing the names and addresses of the shareholders of record; and that the assistant secretary was illegally ejected from his office at Jersey City at the instance of Rice.

5. That "unless a receiver is appointed for the protection of the rights of the said corporation and its creditors and stockholders . . . said Rice will wreck, ruin, and utterly destroy said defendant, thereby causing its assets and property to be wasted and dissipated."

Little comment is needed. Manifestly, the complaint tells only one side of the story; but, even allowing for this, the facts are evident. Butler and his associates put themselves completely into Rice's hands by allowing him to name the majority of the board of directors, and by placing their stock in escrow. Rice never plays unless the cards are stacked. He had but one purpose in view: to sell stock, purchased by him at from 10 cents to 30 cents

per share, to the public at prices inflated by manipulation on the stock exchange. To further this end, he spent the funds available in Idaho for doing work concerning which extravagant reports could be made; he was not interested in developing the property in accordance with reasonable engineering practice. The Butler faction now finds itself with no intelligent development accomplished; with no funds to prosecute work; with less than half the shares of the company in its possession; and with no control over the company—unless, of course, expensive litigation changes the present status and Rice is ousted from the position he now holds.

It is well to point out that in the foregoing the most favorable possible construction has been put on the actions of Mr. Butler and his associates. It is assumed that they had no desire or intention of profiting from Rice's manipulations, further than to obtain money for legitimate development of the mining property. *Engineering and Mining Journal* has always held the view that nothing but disaster can come from an alliance with an unscrupulous promoter. The debacle in the present case gives convincing support to this contention.

The Alternative to Wasting Money in Research

WASTE is to be deplored, for many reasons, particularly when it follows the launching of a worthy project. Research is usually to be commended, except when it leads to an unnecessary duplication of investigations or to misdirected effort. Many economic surveys are barren of result because they have disclosed a condition that could have been inferred at little cost by an investigator of broader mental caliber and wider experience. In technology and in science it is usually unwise or impracticable to rely on inference to an extent justified in other fields; hence the tendency to favor intensive research leading to positive data.

The chief danger to be found in an undue reliance on research as a panacea for all economic ills and for the solution of all technical problems lies in misdirected effort on the part of the investigator, on the one hand, and the availability of too much rather than too little capital, on the other. Poverty is the greatest incentive to achievement. Frugality and the use of common sense instead of cash do not merit the sneers of the research worker who is well provided with money and materials. The best technical work has always been done in developing methods for handling and treating lean and refractory material. There is less incentive for real research on the part of the employee of a wealthy corporation that plans to capture a rich field. The technical scheme resulting may be expensive and complicated.

Direction of industrial research may cramp progress in some instances, but generally it is advisable and beneficial. On the other hand, research that must conform to a basic requirement that is illogical—the utilization of equipment of a specific size or character, for instance—is worse than unscientific. Too much research may merely elaborate what is obvious to the experienced technician; or it may stress the unimportant; and need arises for common-sense counsel and wise direction, lest large sums of money be wasted. As Sir Ernest Rutherford is reported to have said at the Liverpool meeting of the British Association for the Advancement of Science recently, "It is fatally easy to spend much money in a direct frontal attack on a technical problem of importance, when the solution may depend on some addition to knowledge in another field of scientific inquiry, which can be gained possibly at a trifling cost." A writer in *Chemistry and Industry* quotes Lord Curzon as saying that "The progress of any science will always depend on the character and ability of the men who devote their life to it, rather than to the money expended in its name."

Between character and ability, on the one hand, and mental mediocrity, on the other, a wide gulf exists. But something more than character and ability is needed to solve industro-technical problems. Many young graduates possess these qualifications to a superlative degree, but they lack any general knowledge of the fundamental common sense of cause and effect in practical operations—they have no background of experience on which to cultivate that sense of keen perception needed as to the probable sequence of happenings in actual practice when an element of change or novelty may be introduced.

Many a research student, filled to the brim with facts, the result of the absorption of specialized data, finds that he has to create a problem before he can make use of his knowledge. The result is usually an appalling waste of money, a waste that might have been avoided by utilizing existing general knowledge in another or in the same field, a waste that pyramids capital expense and raises the cost of the ultimate product. Research is decried, whereas complaint should be directed against the conduct of the investigation in the first place, and the failure to study those fundamentals that are scorned by many research workers. A courageous analysis of the results of the work of what may be termed "green graduates" is contained in an annual report of Dr. F. J. E. Woodbridge, dean of the Graduate Faculties of Columbia University, who avers that from two-thirds to three-quarters of the graduate students are of negligible scholastic standing. The New York *Herald Tribune* comments in caustic terms, maintaining that the title of doctor should mean "A person to whom learning is a living truth, not merely a set of dead facts embalmed between the covers of books." It adds pertinently that "Strong meat is for adult stomachs and scholarship for brains that have capacity to grow up."

The successful direction of research necessitates high interpretative ability, infrequently discernible in doctorate theses. Graduates accustomed to the use of equipment and references supplied on a lavish scale seldom realize that industrial competition is keen, and that directness in the evolution of a process is highly essential. History has shown that the stimulus to do the job simply and economically is absent under conditions indicating the availability of unlimited or almost unlimited funds. Frugality in research is too often decried by inference; and bank accounts rather than brains are drawn upon. An industry that enters world competition with a heavy amortization charge for research and pilot-plant work that has led to greater complication rather than to greater simplicity sets a dangerous precedent in discouraging what may be done by plain investigation and high thinking. Too often the propaganda accompanying a heavy expenditure for so-called research, usually along predetermined and restricted lines, has completely overshadowed the possibilities existing in the direction of a cheaper and simpler line of attack.

What Are the Essential Qualities of Leadership?

IN A BROCHURE recently issued, our esteemed colleague, Dr. H. C. Parmelee, editor of *Chemical and Metallurgical Engineering,* has crystallized the essentials of the service renderable by technical journalism to industry in the following sentences:

"Obviously, the first duty of a technical journal is to keep its readers posted on progress in technology. They look to it for useful information. . . . They expect instruction, not entertainment. They hope to enhance their knowledge, improve their ability, and get something of definite utility in return for their money and time spent in reading. This puts a corresponding obligation on the editors to know what is going on, comb the field for the best practice, and obtain the co-operation of the most reliable contributors.

"Needless to say, the editors cannot create such material. But if they are alert and competent they know where to find it. And they get it through personal contact, travel, and correspondence, which means something more than sitting at a desk and drawing on the imagination or clipping contemporary publications. Initiative, resourcefulness, knowledge, vision, confidence, courage—all are important; but without courage the others are likely to be impotent and ineffective."

The easiest attitude for a publication to take is to "sit on the fence." It is a popular attitude, because the alternative invites criticism. But it is impossible to please everyone, and it is impracticable to mold policy in line with the multitude of divergent views held by readers, some of whom appear to have the impression that the subject that fills their life and thoughts should receive the undivided attention of the editorial staff. It were better if more readers could realize the mechanical problems that are a part of daily routine in an editorial office.

Mistakes are avoidable only by those who are dead or out of the running; they form part of any scheme of real education and advance, and they offer valuable aid in any effort at mental readjustment and orientation to fundamental principles. A leader in industry once averred that it were better to do something than to stagnate, "even if you do it wrong." Mistakes are repeated only by the careless, however. Initiative and action must eventually decide what constitutes the essential qualities of leadership in every phase of human endeavor.

Statistics Indicate Prevalence of Fake Mining Promotions

MORE in sorrow than anger, attention is directed to a survey recently concluded by the National Better Business Bureau, which indicates that the fake stock certificate is the favorite tool of the unscrupulous promoter, with mining as the chief means for attracting the gullible, oil coming second. Such a conclusion is hurtful to the mining industry as a whole. The frequency of inquiries received in the office of *Engineering and Mining Journal,* requesting information as to the dividend standing and prospects of our leading mining ventures, indicates that publicity within the industry in regard to successful financial results and prospects has been inadequate. If the professional and other workers in an industry are ignorant of the standing of the reputable corporations in that industry, the circumstance that the general run of investors can easily be persuaded to sink their savings in fake mining promotions appears to be an inevitable corollary.

If it be reasonable and desirable that an employee of a corporation should hold stock and take an interest in the affairs of that corporation—as is held by many progressive executives—it is equally logical to conclude that those who earn their livings in an industry should invest at least a substantial proportion of their savings in that industry. Assuming the acceptance of this thesis, it is evident that the time is propitious for adequate publicity within the industry as to the financial status and commercial prospects of mining corporations of standing and promise. Until the members of the mining industry, including all types of workers, becomes investors in the mining industry, we will have no large body of public opinion in the industry to insist on the reforms that can only be brought about by group influence. The encouragement of such investment would appear to be highly desirable.

A Contribution to Human Progress and Happiness

AN EVENT OCCURRED on Dec. 2 for which millions of persons all over the world had awaited with keen interest: the appearance of the new Ford car. Of the familiar "Lizzie," its predecessor, it can be said that no single product of inventive organizing genius has attained the record, deserved the acclaim, merited less ridicule, and conferred the benefits on practically every race of mankind that must be credited to this contribution to improved transportation. Mass production raised to its highest known power has sent forth fifteen million cars of the Ford type, every single one of which, it is reasonable to conclude, has contributed to the general advance of civilization and to happiness, contentment, and efficiency: by improving transportation, especially in isolated communities; by the encouragement of countless campaigns for good roads; by providing wholesome recreation to millions through travel; and by advertising to all the world American genius, organizing ability, and opportunity. Noteworthy, also is Mr. Ford's recognition of the economic soundness and efficiency of cost control by embarking in allied manufacturing and basic material production ventures, which, co-ordinated with the main business of automobile production, has made it possible to sell a high-grade product at a low price and at a small margin of profit.

From the New York *Evening Post* of Dec. 3 we cull the following account of the latest in automobiles:

"The new Ford is new; but it isn't a Ford. It is swung low (sweet chariot); it is the color of fog at sunrise or of trees at dawn; it has theft-proof coincidental locks, pressure grease-gun lubrication and five steel-spoke wheels; it is as silky as a debutante and as neat as a watch; it will go 65 miles an hour and 30 miles on a gallon; it has a gas tank behind the engine and a switch for all lights on the steering post; it was made with Johannsen precision gages, accurate to the incalculable fraction of an inch, and it wipes its own windshield; it is masculine in reliability and feminine in grace; it is, in other words, the heart's desire of America."

Present prices suggest the possibility that the well-to-do may order Fords by the dozen—in assorted styles and colors. Those of us of modest means will probably have to be content with two or three—unless the family be large and varied in its tastes, as sometimes happens.

The Importance of Mining-Industry Byproducts

THE MINING INDUSTRIES are becoming increasingly dependent on chemical engineering; and much of the technique of modern progress in this field of endeavor has been developed by the metallurgist. Between metallurgical engineering and chemical engineering no line of demarcation can be drawn: a specialist in either may invade the alternative field and still find himself at home. For thirty years or so chemistry has played a vital rôle in metallurgical advance, in the efficient extraction of metals from ore by new processes, and in wet methods of recovery and refining. Electrochemistry has solved and is solving many a difficult metallurgical problem.

AMONG chemical byproducts of a mining industry, and one that occurs in a country that may be said to possess a monopoly in this respect, is iodine, almost the entire world's supply of which is obtained from the leach liquors resulting from the recovery of nitrate from Chilean ore. The subject is of special importance in view of the recent announcement that the future control of the iodine industry is to be taken over by the Chilean government. Previously, producers were obliged to become members of an association that determined quotas and restricted production to a point insuring a maintenance of a uniformly high price. The deliberate waste of all but an insignificant proportion of the country's reserves in iodine was the inevitable sequel to the adoption of this policy, a condition that at last, apparently, is recognized as serious.

IODINE is recovered by a messy and complicated process, involving the maximum of personal discomfort to workers, perhaps a hazard to health, and a serious loss by theft. It is said that almost the entire requirements for iodine in South America are supplied by what is regularly stolen. The only product manufactured is over 99 per cent purity, mainly for the drug trade. In the process of recovery the mother liquor is "cut" with bisulphite or other agent, and the precipitated iodine is settled by gravity or floated by air. It is then filtered by gravity in bags, pressed, and the resultant "cheese" is sublimed. Filtering and subliming are long and tedious operations. The semi-spent liquor, because of the presence of elemental iodine that cannot be removed by known methods, is highly corrosive. Metal containers, pumps, piping, and other equipment are rapidly destroyed. To reduce corrosion of the leaching plant, this liquor is usually boiled, to drive off the iodine into the atmosphere, before or as soon as it is returned to the circuit. The small barrel in which the final product is shipped must be inclosed in a sewn rawhide covering.

THE subject of the possible uses for iodine and iodides in the chemical industry has not been given adequate consideration. An expensive sublimed and purified product only is available, the cost of which inhibits research. Chilean records show that nearly all, if not all, of the early production was exported in the form of copper iodide, probably until about 1879. This product was evidently made from imported copper sulphate, the cost of which was doubtless high. A common present-day method of preparing the "cutting" reagent involves the burning of a mixture of coal and sodium nitrate to form a carbonate, which is combined with the product of combustion of sulphur to form the bisulphite Incidentally, the nitrogen already recovered in the form of nitrate is lost in the air. Curiously enough, no attention seems to have been paid by iodine technologists to the fact that in recent years Chile has developed a metallic copper industry of the first magnitude. Iodine corrodes copper as readily as it corrodes other metals. The product is a compound of great industrial promise. It has application in the chemical industries, or it can be dissociated into copper and iodine efficiently and economically. The separation can be made away from conditions involving theft and expensive operation. Copper iodide is inert, stable, innocuous and insoluble in water, and therefore in ideal form for shipment. It can be prepared instantaneously at small cost, without hazard; the separation of iodine from the solution may be effected by the use of ordinary equipment. Incidentally, its preparation renders a mother liquor non-corrosive. The economical recovery of iodine as an iodide in Chile in large quantities would be possible thus, theft would be minimized and an ultimate recovery of the final product made in the country of destination. The corrosive action of iodine can thus be capitalized.

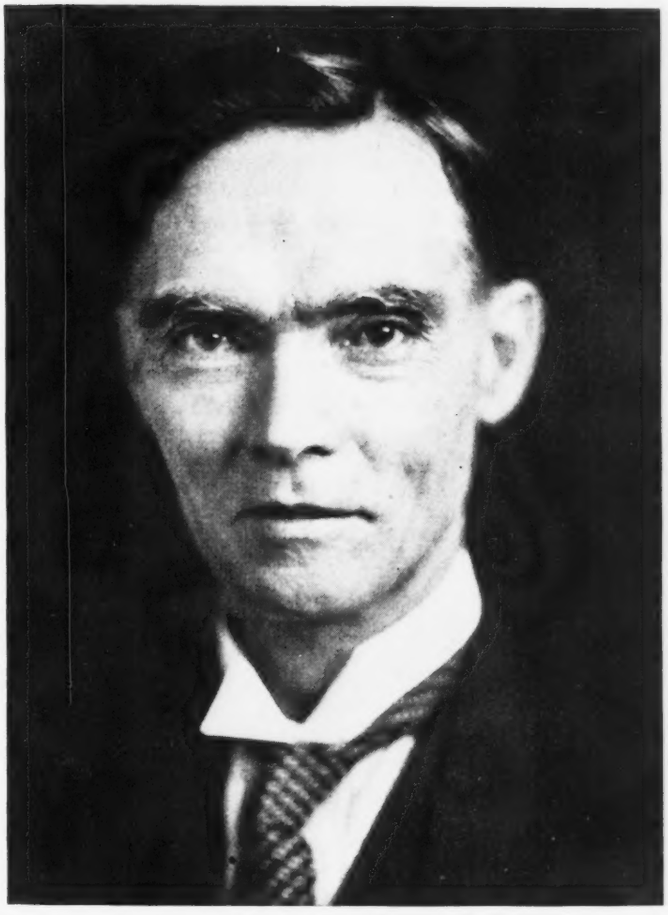
OSTENSIBLY, the iodine association has welcomed suggestions that might lead to the wider use of the product, but as a matter of fact all proposals have been discouraged that hinted a reduction in price, even though a much larger market was promised. A process for the recovery of copper from leach solutions was proposed recently, involving the addition of iodine, the formation of copper iodide, the recovery of the copper, and the return of the iodine to the circuit. The inventor is a Chilean metallurgical engineer. In this work the usual superfine product was used, with results that might have been expected from the economic standpoint. An abnormal loss of iodine in a pilot plant of the character of the one operated at Santiago de Chile was unavoidable. If a cheaply produced copper iodide were introduced into the circuit at the point where this compound was normally formed, a greater scope for success would be apparent.

THE use of iodine as a medicament has been narrowed of late by the development of a substitute, mercuro-chrome, an American product the application of which is painless, in distinct contrast to the effects of iodine on an open wound. Mercuro-chrome contains bromine in small quantity. The bromine industry, by the way, has forged ahead as a result of technical research, with significant increase in consumption. The iodine trade has remained stationary, with an appalling wastage at the source. The moral is obvious. If iodine and the iodides could be purchased at a reasonable price it is more than probable that uses would develop in several industro-chemical fields—in aniline dye manufacture and for the refining of petroleum, for example. No industry ever achieved continued financial success by deliberate waste, and no progressive government can be expected to accept such waste as an inevitable concomitant to commercial operations of any kind. The marketing of iodine and of copper iodide at a reasonable price would greatly aid Chilean development and increase the profits from the nitrate-mining industry. The tail will never wag the dog, but additional income from byproducts is always of considerable help.

Dr. E. C. Andrews and *Mining in Australia*

An Interview by A. B. Parsons

"COME and lunch with me and we can have a good yarn." That invitation could, I think, come only from an Australian, for the colloquialism, like the kangaroo, is distinctive of the world's smallest continent and largest island. At any rate it *did* come from a distinguished Australian scientist, the government geologist of New South Wales, Dr. E. C. Andrews. He is now in the United States, giving lectures on geology and allied subjects at Yale, Columbia, Harvard, Princeton, Wisconsin, Toronto, Cincinnati, and other universities. Dr. Andrews evidently has had a good many "yarns" with men who were more fruitful sources of information than the present writer, to judge from the knowledge he has of countries other than his own. He knows the United States, Canada, Europe, Japan, Malaysia, India, first hand, and the rest of the world through reading and contact with other men. Though geology is his forte, he is a student of other sciences, of economics, politics, and sociology. He is a seeker after fact. "When human beings know the whole truth about this world there will be little left to live for," says Dr. Andrews, adding, with a characteristic smile, "but we are not in grave danger of working ourselves out of a job." He was born in Sydney in 1870, and his home has always been there. At Sydney University he studied science, mathematics and geology—the latter under Prof. T. W. E. (Sir Edgeworth) David. It was the inspiration of Prof. David that diverted Dr. Andrews from his first plan to become an actuary. Incidentally, Dr. Andrews has no doctorate degree; people have forced the title on him, and he says he has abandoned protests as being futile. He joined the Geological Survey of New South Wales in 1899; in 1908 he visited the United States and Great Britain for the first time. One accomplishment on this visit was the climbing, with a single companion, of Mount Darwin, a 14,000-ft. peak in California. Australia has no high mountains, and Dr. Andrews had an ambition to be the first man to reach the top of some fairly high peak. Mount Darwin was up to that time "unclimbed," and for that reason it was selected by Dr. Grove Karl Gilbert, of the U. S. Geological Survey, as a fit victim for the visiting Australian geologist. Dr. Andrews again arrived in the United States in March, 1927, and started his lectures. During the summer he went to London and returning to this side of the Atlantic, toured Canada with the British Empire Mining Congress. At technical sessions he always made some worth-while contribution to the discussion; and his sparkling stories saved some of the formal and informal social occasions from ponderosity.



DR. E. C. ANDREWS

Among the subjects of the official reports that Dr. Andrews will take back to New South Wales next January are: Fuel research directed toward the production of a good metallurgical coke; power-plant economics; road-making materials; and geophysical methods of prospecting. He has written numerous books, and is probably best known for his brilliant report on the Broken Hill district, published in 1922 as the result of a survey started in 1917.

To say that Dr. Andrews knows Australia and Australian mining from A to Z is unnecessary. Naturally, the future of the mining industry is of more significance

than past performances. However, in reply to a question, Dr. Andrew summarized the history as follows: "The first important metal mining was started at Burra Burra in South Australia in 1844. This was a copper mine, which incidentally later gave its name to the well-known mines at Ducktown, Tennessee. The first gold discovery was made by a forty-niner from California in 1851. And the next year Ballarat and Bendigo, in Victoria, were found. Later, in Western Australia, came Kalgoorlie, with its "Golden Mile," perhaps the richest big gold district the world has known. Kalgoorlie and Bendigo each produced $425,000,000 and Ballarat $350,000,000. Copper and copper-gold districts are represented by Mount Morgan, with a production of $150,000,000, Wallaroo, Moonta, and Cobar, collectively with a production figure approximately equal to that of Mount Morgan. Tin mines in Queensland, New South Wales, and Tasmania contributed $210,000,000 to Australia's metal production, and Mount Lyell has added $90,000,000 in copper. Broken Hill—and I could tell you as romantic tales as ever were heard about the early prospectors of the region—was first actually pegged in 1883. It has produced about $750,000,000 in lead, silver, and zinc. Although there now are four active companies operating along the lode, and have been others, the ores come in fact from a single deposit. Excepting only Anaconda Hill, in Montana, it has, I believe, produced more metal wealth than any equal area in the world. All told, Australia has produced nearly $5,000,000,000 worth of metals. Compared with the United States that is not much; but you in this country, with half the world's known supply of the major metals within your borders, ought to allow a handicap to other countries when comparisons are made. Counting coal, oil, and non-metallic minerals, your production was worth about $6,250,000,000 in 1926 alone!"

Australia, one must confess, has a creditable record for past production. But what of the present and of the future? Broken Hill continues to produce at the rate of 1,000,000 tons per year of silver-lead-zinc ore considerably richer than similar ores mined in the United States; and Mount Lyell is producing copper profitably because of cheap power and the making of acid and super phosphate as byproducts. I pointed out, however, that the mining industry generally cannot be described as healthy; that the ore now remaining in the old districts is not so rich as the ores once were; and that an important factor in the decline is the social and political situation and the consequent increased cost of mine operation. Dr. Andrews, because of his position in the government service, asked to be excused from commenting on these matters, vital though they are. He did, however, discuss the future outlook from a broad long-time point of view. He said:

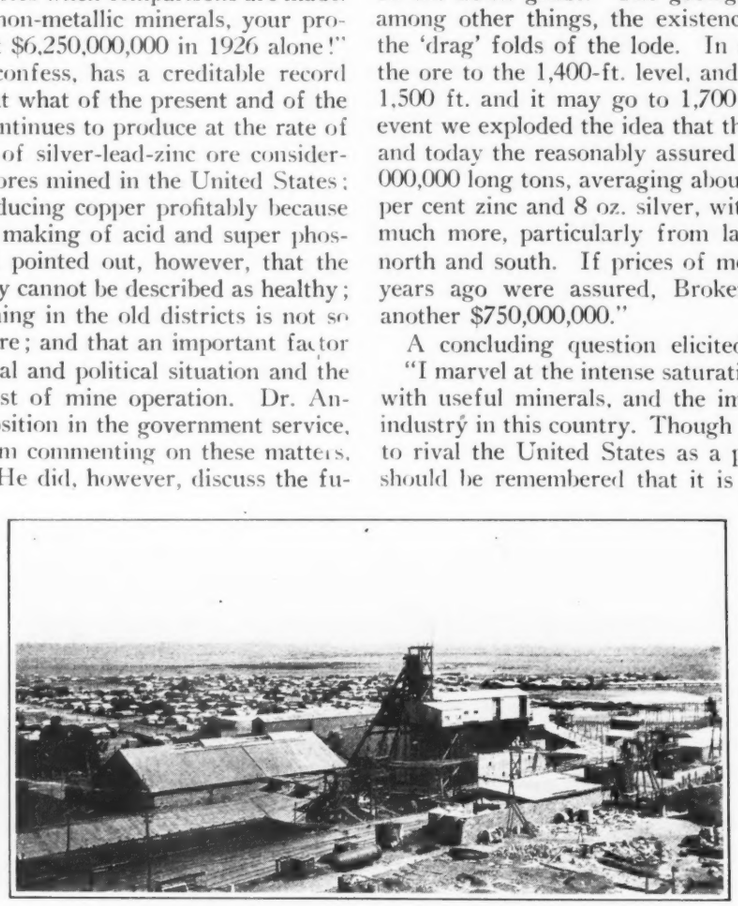
"Thus far the mines have been found in a fringe around the south and east coasts. Even these areas that are comparatively accessible, and where the ore-bearing rocks are close to the surface have not been thoroughly and systematically prospected. In addition, there is some 2,000,000 square miles in the west and northwest that are practically unexplored as far as minerals are concerned. The rocks are Pre-Cambrian, equivalent to those of the great Canadian Shield, and similar to the rocks of the South African gold fields. Tin and some of the other metals are not likely to be found, but there is excellent reason to expect gold, iron, silver, copper, lead, and zinc and perhaps nickel.

"Eventually these regions will be mapped geologically. The most promising areas will be ascertained; and geophysical prospecting methods will be brought into use. I am greatly impressed by what I have learned about the various methods of investigation by geophysical methods. I am confident that with geological conditions as they are, it is only a question of time before other Kalgoorlies, other Broken Hills, and other Mount Morgans will be found."

I asked about Mount Isa, the new area in Queensland that has recently been acquired by the Russo-Asiatic interests, which have started active development. Dr. Andrews said: "I have not been up there, worse luck! However, fifteen years ago the entire Cloncurry field in which Mount Isa is situated was looked upon as being of doubtful value. If, as seems probable, an important mining district is established, the frontier, so to speak, will be pushed back a little further westward, and another step will be taken in the development that I have suggested as being inevitable."

"What is the outlook at Broken Hill?" was the next question. "I could give two or three complete lectures on different phases of Broken Hill," said Dr. Andrews. "However, I may say briefly that before the war it was believed in many quarters that Broken Hill was definitely on the down grade. The geological survey established, among other things, the existence of an undulation of the 'drag' folds of the lode. In one place we projected the ore to the 1,400-ft. level, and it is now developed to 1,500 ft. and it may go to 1,700 ft. or deeper. In any event we exploded the idea that the mines were decadent, and today the reasonably assured reserves are about 13,000,000 long tons, averaging about 12½ per cent lead, 11½ per cent zinc and 8 oz. silver, with a high probability of much more, particularly from lateral extensions to the north and south. If prices of metals that prevailed two years ago were assured, Broken Hill would produce another $750,000,000."

A concluding question elicited this prophetic reply: "I marvel at the intense saturation of the United States with useful minerals, and the immensity of the mining industry in this country. Though Australia never is likely to rival the United States as a producer of minerals, it should be remembered that it is a comparatively young country; it has more of its life left before it. The fact that so many rich mines have flourished in Australia in the past is a good indication; the country almost surely contains vast valuable mineral deposits that will some day be exploited. I feel sure that the day will come when Australia will be producing mineral wealth at a greater rate than at any time in the past."



New South mill at Broken Hill

Experimental Work Indicates Practicability of

Reduction of Tin Ore With Hydrogen

Second of a Series of Articles Based on Physico-chemical Studies in the Metallurgy of Tin

By C. G. FINK and C. L. MANTELL

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IN ORDINARY smelting operations, the coal or coke of a reducing charge is active only as it becomes partly oxidized to carbon monoxide gas. Reduction of metallic oxides is not accomplished by reducing fuels in the solid phase. If a more efficient, cheaper, and more easily manipulated process would result from the gasification of the reductant, outside of the smelting furnace, the possibility of developing such a process deserves careful consideration. The gaseous reduction of tin concentrates has been studied with this end in view.

Tin in metallic form has a low melting point. It is different from most of the other metals occurring in the combined state in nature, in that its only ore is the dioxide, the reducing temperature of which, by gaseous reductants, is above the metal-melting point. Reduction of cassiterite by hydrogen is complete at temperatures several hundred degrees below that at which "carbon reduction" takes place at any appreciable rate.

Present reverberatory and blast-furnace practice in the metallurgy of tin requires temperatures of 1,300 to 1,400 deg. C. Hydrogen reduction may be effected beginning at 250 deg. C., and the most economic point is between 750 and 800 deg. C. The choice of hydrogen is suggested by the location of the world's largest tin orebodies, such as those of Bolivia, in regions far from coal but in the midst of sources of water power. "Smelting with water" seems to be the obvious answer to the problem.

GASEOUS REDUCTION OF METALLIC OXIDES

Gaseous reduction was first investigated in 1830 by C. Despretz,[1] who reported that hydrogen and carbon monoxide each reduces stannic oxide to tin metal. W. Müller[2] reported his work on heated oxides in contact with hydrogen in sealed glass vessels. He showed that many metallic oxides give evidence of reduction at temperatures from 200 to 400 deg. C.

A. E. Arnold[3] and W. Hampe[4] propose hydrogen reduction of tin ores for one or two hours on a 1-gram sample at a red heat as an analytical test. They point out the advantage of the ease of separation of the reducible oxides of the metals from those non-reducible (those of silica, non-metallic minerals, gangue) by acid treatment of the reduced charge and resulting metal solution.

I. L. Bell[5] reports that stannic oxide does not show appreciable reduction after a six-hour treatment with carbon monoxide at the temperature of melting zinc (419 deg. C.). This has not been agreed to by later investigators, and our own work shows that it is not true.

Hammick[6] showed that sulphur dioxide does not react with stannic oxide, even at red heat. He also demonstrated that sulphur dioxide oxidized the lower oxide of tin (SnO) to stannic oxide. These reactions preclude the possibility of sulphur dioxide acting as a reducing agent in this operation. Vortman[7] has patented the use of stannic oxide as a catalyst for the conversion of sulphur dioxide to sulphuric acid.

REDUCTION OF STANNIC OXIDE BY HYDROGEN

Reduction of stannic oxide by specially purified hydrogen was studied between the temperatures of 250 and 1,000 deg. C. Determination of the rate of change of velocity of the reaction

$$SnO_2 + 2H_2 = Sn + 2H_2O$$

with change of temperature, was made. The velocity of reduction-temperature curve was considered basic. No data exist in the literature. The method of determination was to subject charges of pure tin oxide to a stream of hydrogen gas which had been carefully purified, the charge of tin oxide being held at a constant temperature (within the limits of the commercial apparatus used) in an electric furnace provided with both amperage and voltage control, with resultant temperature control. Provisions had to be made for a source of pure, dry hydrogen gas; and most of the apparatus required is employed in the purification of the hydrogen. Temperatures at which the charges were maintained were taken by means of a high-resistance Hoskins chromel-alumel pyrometer and a thermo-couple of No. 22

[1] Ann. chim. phys., (2), 43, 222 (1830).
[2] *Chem. News*, 36, 238 (1877).
[3] *Chemik. Zeit.*, *II*, 19 (1887).
[4] Poggendorf Ann., 136, 51 (1864); 153, 332 (1875).
[5] Bell, *Chem. News*, 23, 258 (1871).
[6] *J. Chem. Soc.*, *III*, 379-389 (1917).
[7] D. R. P. 316,858 (1919).

B. & S. gage chromel and alumel. The pyrometer instrument, leads and thermo-couple were previously calibrated together.

The procedure for the preparation of the tin oxide charges was as follows: An alundum boat was partly filled with 60-mesh carbon-free sintered alundum and the boat and material were ignited for a half hour in an electric furnace at 800 deg. C. Both ends of the furnace were open. For identification this furnace will be termed the "oxidizing" furnace. After ignition for 30 minutes the boat and alundum were withdrawn from the furnace (the furnace being kept constantly at 800 deg. C.) and cooled to room temperature in a desiccator over sulphuric acid. The boat was then ready, after cooling, for the stannic oxide charge. Boat and alundum were weighed on an analytical balance, a charge of stannic oxide spread over the alundum in a thin layer. The boat, alundum, and stannic oxide were then again ignited in the oxidizing furnace for 30 minutes, and the treatment was repeated until constant weight was obtained. Boat and charge were removed from the furnace at 800 deg. C., placed in a desiccator, and dryed to room temperature over sulphuric acid. Boat and charge were then ready for reduction.

In all the runs the charges were placed in the "thermal center" of the silica tube of the reducing furnace, the desired temperature being approximated by setting the amperage on the furnace. The amperage-temperature characteristics of the furnace had previously been determined. The furnace was allowed to come to equilibrium, when the exact temperature was measured by the pyrometer. Hydrogen was then introduced into the system at a definite rate, purified, and the reduction of the oxide charge allowed to take place over a definite time interval.

Table I—Data of Tests with Stannic Oxide

Test No.	SnO_2 in Charge	O_2 in Charge	Loss After Reduction	Per Cent Reduction	Per Cent Sn in Residue	Time of Run	Temperature Degrees C.
B 1	3.2190	0.6820	0.0560	8.23	80	1 hr.	850
B 2	2.3633	0.5020	0.1700	33.9	85	7 hr.	850
B 4	1.7248	0.3760	0.3762	100.0	100	32 min.	760–780
B 5	2.1680	0.4726	0.3475	73.5	93.13	20 min.	780–800
B 6	2.6337	0.5742	0.6625	100.0	100	30 min.	.....
B 7	2.5204	0.5494	0.4359	79.34	94.5	15 hr. 50 min.	670–700
B 8	2.2053	0.4808	0.4798	100.0	99.94	41 min.	280–280
B 9	1.2347 (85%m)	0.7017	0.7553	100.0	100	1 min.	850
B 10	2.0417	0.3320	0.4894	100.0	100	8 hr. 30 min.	450
B 11	4.0342	0.8553	0.8872	100.0	100	6 hr. 40 min.	480
B 12	4.2583	0.9029	0.7617	84.37	96.0	14 hr.	320
B 13	3.3530	0.7108	0.6749	94.95	98.66	7 hr. 50 min.	360
B 14	4.7328	1.0030	0.5734	57.16	89.73	1 hr.	490
B 15	5.7575	1.2200	0.7406	60.67	.....	22 hr. 30 min.	250–270
B 16	4.5769	0.9703	0.1579	16.27	.....	6 hr. 40 min.	290
B 17	4.4066	0.9342	0.4372	45.95	.....	23 hr. 25 min.	250–270
B 18	2.3154	0.4909	0.3898	79.4	.....	21 hr.	280
B 19	2.8430	0.6027	0.6485	100.0	.....	10 hr.	510
B 20	2.1167	0.4487	0.3005	67.2	.....	24 hr.	280
B 21	2.2344	0.4737	0.4961	100.0	100	8 hr.	400
B 22	1.9390	0.4011	0.4232	100.0	100	30 min.	600
B 23	2.1520	0.4564	0.4862	100.0	100	3 hr.	480
B 24	2.8121	0.5962	0.6035	100.0	100	7 hr.	380
B 26	3.9427	0.8359	0.5837	68.87	.....	12 hr.	335
B 27	3.0141	0.6390	0.6452	100.0	100	10 hr. 10 min.	390
B 28	2.1085	0.4470	0.4898	100.0	100	15 min.	680
B 29	1.1752	0.2491	0.0560	22.5	.....	22 hr. 35 min.	270
B 30	2.0498	0.4346	0.4397	100.0	100	36 hr.	310–320
B 31	1.7872	0.3789	0.3723	98.2	.....	41 hr.	280–290
B 32	.....	.....	.....	.....	.....	.....	.....
B 33	1.1545	0.2443	0.3170	100.0	100	15 min.	740
B 34	2.2690	0.4810	0.3437	85.2	.....	35 hr. 40 min.	290
B 35	1.2275	0.2602	0.2622	100	100	15 min.	710
B 36	0.9830	0.2084	0.0452	21.7	.....	5 min.	670–705
B 37	0.9972	0.2114	0.1850	87+	.....	1 hr. 3 min.	510
B 38	1.3244	0.2808	0.2790	100( )	100( )	1 hr.	510
B 39	1.0775	0.2284	0.1062	46.5	.....	12 min.	595–600
B 40	1.5912	0.3373	0.0337	10	.....	5 min.	600
B 41	0.9803	0.2078	0.2225	100.0	100	5 min.	790
B 42	0.6932	0.1370	0.1385	100.0	100	33 hr. 30 min.	390
B 43	1.0465	0.2219	0.2346	100.0	100	5 min.	690–705
B 44	1.1579	0.2455	0.0863	35.15	.....	3 min.	785
B 45	0.8965	0.1901	0.0089	36.5	.....	10 hr. 30 min.	390
B 46	1.0918	0.2315	0.1168	50.4	.....	20 min.	510
B 47	1.0812	0.2292	0.2258	98.4	100	15 min.	510
B 48	0.9189	0.1945	0.5579	.....	.....	17 hr.	.....
B 49	1.0108	0.2143	0.0453	21.12	.....	20 min.	510
B 50	2.0018	0.4240	0.0863	20.18	.....	12 hr. 20 min.	280
B 51	1.2270	0.2602	0.2610	100	100	3 min.	850

At the end of this time interval, the current was turned off, and the hydrogen flow was stopped and replaced by nitrogen, from which oxygen and carbon dioxide had been carefully removed. The furnace and charge was then allowed to cool by radiation in an atmosphere of nitrogen.

When the charge had cooled at least to 30 deg. C. below the melting point of tin (232 deg. C.), the nitrogen was shut off; the furnace was opened, and the charge removed to a desiccator, where it was cooled to room temperature, and dried in the desiccator. The boat and charge were then weighed and the loss in weight of the stannic oxide caused by the reduction was determined by subtraction of the weight after reduction from the total weight before reduction. Reductions were all expressed in percentages. The percentage of oxygen removed from the stannic oxide, divided by the total weight of oxygen in the stannic-oxide charge, equaled the percentage reduction. The percentage of tin in the residue was also calculated for all runs. It was equal to the amount of tin in the original charge divided by the weight of the residue remaining. Of course it follows that with 100 per cent reduction there would then be 100 per cent tin in the residue. Data of the runs are given in Table I.

The hydrogen used was made either in a glass hydrogen generator, employing a 30 per cent sodium hydroxide electrolyte; or in a Shriver laboratory-size filter-press type generator, employing a caustic electrolyte and bipolar electrodes. The impurities contained in this gas were nitrogen, oxygen, water vapor, carbon dioxide, and, at times, sulphides. Water vapor was removed by the use of soda-lime and phosphorus pentoxide.

Oxygen was removed by partial combustion of hydrogen in the presence of a catalyst. Palladium black, on ignited asbestos at 350 deg. C., was found to be efficient for this work. Water formed as a result of the combustion of the hydrogen was removed subsequently by the use of soda-lime and phosphorus pentoxide. Palladium black catalyst was made by saturating acid-washed asbestos with a solution of palladious chloride, followed by careful drying and igniting. It was found, however, that the finely divided palladium in its black condition was not formed until the ignited mass had been subjected to reduction by hydrogen. Before reduction by hydrogen, the ignited mass was brownish or red-brown in color. Nitrogen as an impurity in the electrolytic hydrogen was present only to such extent as would be accounted for by dissolved air in the water which had been electrolyzed. It was not found possible to remove this small nitrogen content. Complete removal of the nitrogen was not necessary, as it introduced no harmful action, but merely served as a diluent for the hydrogen. Carbon dioxide along with moisture was removed by absorption in soda-lime towers.

Sulphur compounds, organic and inorganic, were removed by a nickel catalytic tube used in the hydrogen purification. Finely divided nickel, deposited on ignited asbestos, was placed in a $\frac{3}{4}$-in. silica tube, electrically heated to 700 deg. C. The gas, after passing through the catalytic tube, was washed in saturated copper sulphate solution. The solution was used in three wash bottles in series, each being three-quarters full of $\frac{1}{8}$-in. glass beads. Beads were used for the purpose of breaking up the gas bubbles and offering greater surfaces of contact for the gas with the absorbing solution.

Nitrogen gas, used for the production of an inert atmosphere, was purified in the same manner as hydrogen,

save that oxygen was removed by chemical combination with finely divided copper at 300 deg. C. A silica tube, filled with finely divided copper suspended on ignited asbestos, and maintained at about 300 deg. C., was used as an absorbent for the oxygen. Copper-asbestos element was made by saturating acid-washed asbestos with a solution of copper carbonate in ammonium hydroxide. The mass was then dried and ignited to copper oxide and the removal of the undesired product of the reaction, water vapor, by causing the gas to sweep across the reacting surface.

With stannic oxide in excess of the amount required to oxidize all of the hydrogen present to water vapor, at any particular temperature, further reduction ceases as soon as the water-vapor concentration has attained N per cent, where N is a function of the temperature. The

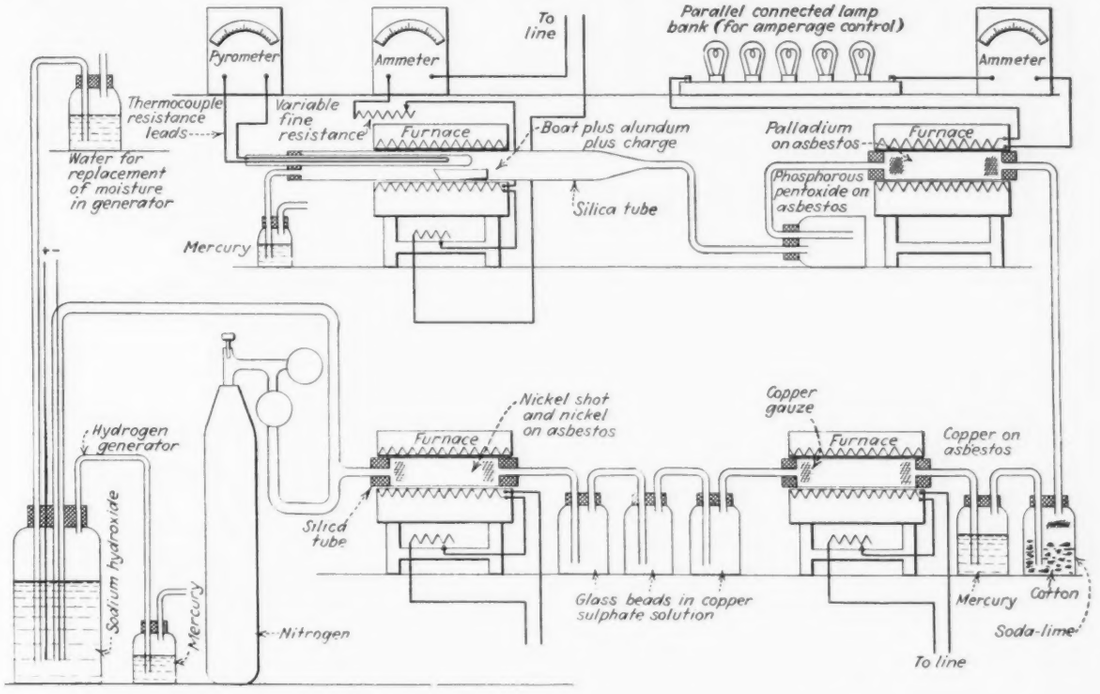


Fig. 1—Arrangement of apparatus for reduction of tin oxide with hydrogen

copper oxide reduced *in situ* by hydrogen. This copper oxide mass served two purposes: First, it removed relatively large amounts of oxygen, leaving the removal of small remaining amounts to the palladium catalytic tube. Second, it removed large quantities of oxygen from the nitrogen used to blow out the hydrogen from the reaction chamber when it was desired to end the time of contact. Of course, the use of nitrogen, containing large quantities of oxygen as an inert gas, was not desirable, as the oxygen in the gas would undo the work of reduction by hydrogen. Nitrogen was used as an inert gas, in the atmosphere of which the reduced charges could be cooled away from the outside oxidizing air.

The apparatus and its arrangement are shown diagrammatically in Fig. 1. The order of removal of impurities of the gases was: sulphides and sulpho-compounds, oxygen, carbon dioxide, moisture, oxygen, and, lastly, moisture from the oxygen-hydrogen reaction in the palladium catalyst tube. Nitrogen originally present in the hydrogen in small amounts was not harmful and served merely as a diluent.

Results of Reduction of Stannic Oxide by Hydrogen

We found that, with carefully purified hydrogen, stannic oxide can be completely reduced to metallic tin at temperatures as low as 250 deg. C. (523 deg. K.). The reaction has been caused to proceed, not as a reversible one, but as an irreversible one, by inducing an excess of the reactant, molecular hydrogen, to act as a medium of value of N varies inversely as the temperature. The hydrogen gas must be supplied at a sufficiently high rate to maintain an excess of reductant for the stannic oxide, and at a velocity high enough to "sweep out" water vapor as fast as it is formed.

There must be sufficient excess of reductant to prevent the reoxidation of the reduced products of the reaction. As the reaction is between a solid material and a gas, the natural inference is that the reduction resulting is a surface phenomenon. Stannic oxide is reduced in two steps or in one step, depending as to whether the temperature employed is below or above the thermal decomposition point of the lower or stannous oxide.

The velocity of the reduction was not the same for all parts of the mass and continued greatest at those points first affected. This same phenomenon has been observed by Hilpert[8] in his work on the reduction of iron oxide by hydrogen and carbon monoxide. This is shown by reduction of a charge of more than 0.5 in. (13 mm.) thick in an alundum boat with no alumina support for the charge. With a time of reduction considerably shorter than that called for by the curve, at any one temperature, a composite charge consisting of a bottom layer of white stannic oxide, a middle layer of black or gray stannous oxide, and a top layer of shiny metallic tin may be produced. Ordinarily, however, with proper charge thickness, partially reduced charges will not show all three forms, but will consist of a bottom layer of stannic oxide and a top layer of stannous oxide; or a

[8]Berichte, 42, 4574-81 (1909).

bottom layer of stannous oxide and a top layer of metallic tin; or, at higher temperatures than the decomposition point of stannous oxide, a bottom layer of stannic oxide and a top layer of metallic tin.

One of the factors affecting the speed of reduction is the diffusion velocity of the water vapor formed as the result of the reduction of the stannic oxide. The thickness of the charge was maintained constant, the surface of the charge was practically constant, and the hydrogen

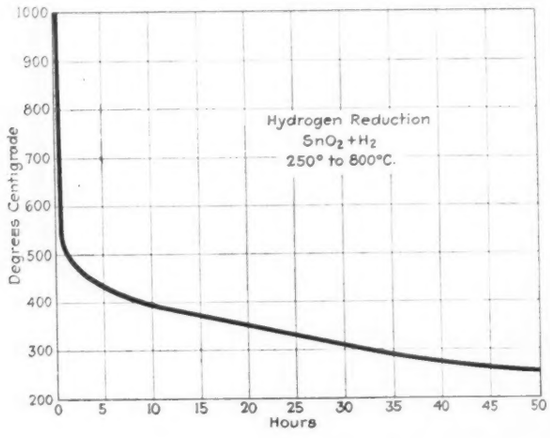


Fig. 2—Curve showing time necessary for complete reduction of tin oxide at various temperatures

flow was constant; the curve showing the variation of reduction with temperature might then be considered to be a curve representing the rate of diffusion of water vapor with variation of temperature.

Many of the totally reduced charges, despite the fact that reduction took place quite above the melting point of tin, did not show marked fusion of the reduced metal. The usual form was a fine gray powder, with very little sintering. With charges of Bolivian ore the reverse held true, and large globules of metal always were produced by reduction of the ore. It has been shown, as a result of later work, that this phenomenon was caused by the formation of bismuth-tin alloys, which have greater fluidity than pure tin. The Bolivian concentrates used contained 0.296 per cent bismuth, corresponding to 0.66 per cent oxide of bismuth.

That in the method of reduction employed, the type of apparatus, and the boat-charge support used for the stannic oxide there is little penetration of the charge by hydrogen does not mean that in practice thick charges of ore or columns of ore could not be reduced easily. The reducing gas in that case need not be blown or swept over the charge, but could be blown through or drawn through the ore that was being reduced.

The boat method is probably the most suitable for experimental work on a small scale. Any other method, such as reduction in columns, requires some material for a lower support which will readily allow the passage of gas without clogging. Column reduction does not allow ease of removal of reduced product or ease of filling, with subsequent ease of weighing and control. It has been shown in our work that with relatively thick charges of ore there must be continuous rabbling in order to expose fresh surfaces.

In a number of runs the loss of weight was greater than was called for by the loss which was effected by the removal of oxygen by the reduction. This error might be attributable to several causes. The boat itself might lose weight as a result of the reduction or as a result of the heating. Alundum is not volatile at any of the temperatures reached and contains no materials or oxides reducible by hydrogen at the temperatures reached. The same considerations hold true for the carbon-free 60-mesh RR alundum used as a charge support. In all the experimentation the boats and supports were brought to constant weight by treatment at 800 deg. C. for a half hour.

Another cause of additional loss might have been the volatilization of the reduced tin metal. This point has been investigated in the literature, and it has been found that tin has no measurable vapor pressure below 1,130 deg. C. This eliminates the vapor pressure of tin as a source of error.

It is highly improbable that stannic oxide, which has a melting point of 1,132 deg. C., would have a measurable or any vapor pressure at the temperatures worked. This would eliminate any source of loss due to volatilization of the stannic oxide.

Wöhler and Balz[9] measured the dissociation pressure of stannic oxide at 1,000 deg. C. under high vacua and reported the oxygen pressure at that temperature to be of the order of 10^{-11} to 10^{-12} mm. mercury. They state that the pressures were very small and exceedingly difficult to measure.

At 1,010 deg. C., Johnston[10] states that the calculated vapor pressure of tin would be of the order of 10^{-3} mm. mercury. Tiede and Birnbrauer[11] state that they found volatilization of tin metal at 880 deg. C. under extremely high vacua. Maeda[12] reports the oxygen pressure of stannic oxide as being 4.47×10^{-15} mm. mercury at 927 deg. C. Williams, Sims, and Newhall[13] found that with an oxidizing blast some tin could be driven off of tinplate scrap in the cupola, but practically none in the reducing atmosphere of an electric furnace, and conclude that the loss is mechanical, and attributable to the burning to oxide, the oxide particles being light enough to be carried off.

Table II—Data of Tests with Ferric Oxide

Test No.	Fe_2O_3 in Charge	O_2 in Charge	Loss After Reduction	Per Cent Reduction	Per Cent Fe in Residue	Time of Run	Temperature Degrees C.
B65	0.8606	0.2582	0.2160	83.6	...	1 hr.	500
B66	0.8290	0.2487	0.1480	56.0	...	45 min.	573
B67	0.4295	0.1285	0.1257	98.0	100	30 min.	504
B68	0.5817	0.1745	0.1612	92.5	...	1 hr.	470
B69	0.4665	0.1400	0.1795	100.0	100	15 min.	815
B70	0.6050	0.1815	0.1992	100.0	100	7 min.	580
B71	0.5429	0.1629	0.1602	98.5	100	15 min.	585
B72	0.6160	0.2048	0.2041	100.0	100	5 min.	822
B76	0.4639	0.1392	0.0752	53.0	...	30 min.	490
B79	0.7690	0.2307	0.2200	95.2	...	3 hr.	350
B84	0.3327	0.0998	0.0942	94.2	...	1 hr.	420
B57	1.7731	0.3759	0.1676	42.5	...	30 min.	450
B78	0.7460	0.2238	0.2164	96.7	...	35 hr. 25 min.	330
B80	0.8002	0.2401	0.1015	41.6	...	3 min.	870
B81	0.6738	0.2021	0.2946	100.0	100	34.5 hr.	340
B83	0.6111	0.1833	0.1979	100.0	100	36 hr.	340
B85	0.1840	0.0552	0.0568	100.0	100	18 min.	680
B86	0.3339	0.2002	0.0951	95.0	...	5 min.	665
B87	0.4434	0.1230	0.1135	92.3	...	5 min.	680
B88	0.2791	0.0837	0.1094	100.0	100	10 min.	670
B90	0.3790	0.1187	0.0440	37.0	...	5 min.	500
B91	0.2489	0.0747	0.0670	90.0	...	30 min.	450
B93	0.1965	0.0589	0.0565	96.0	...	22 min.	455
B94	0.2061	0.0618	0.0449	73.0	...	20 min.	455
B95	0.3485	0.1045	0.0477	46.0	...	20 min.	450
B97	0.1938	0.0581	0.0468	80.0	...	3 min.	785
B96	0.2460	0.0738	0.0686	92.0	...	30 min.	455
B84	0.3327	0.0998	0.0942	94.0	...	1 hr.	420

It is not at all likely that, at any time when stannous oxide was formed as a result of the reduction, it would reach an appreciable vapor pressure sufficiently high to cause any loss by volatilization. It will be shown later

[9]Z. Electrochem, 27, 406-19, (1921).
[10]*Ind. and Eng. Chem.* Vol. 9, 1917, p. 873.
[11]Z. Anorg. Chem. V. 87, p. 129 (1914).
[12]Bull. Inst. Phys. Chem. Res. (Japan) 2, 350-61, (1923).
[13]*Trans.* Amer. Electrochem. Soc. 1923.

in this work that stannous oxide is thermally decomposable above 385 deg. C., and is stable only above this temperature.

The last and probably true explanation for the excess loss is that the exceedingly fine particles of stannic oxide

Table III—Data for Curve Shown in Fig. 2

Test No.	Per Cent Reduction	Temperature Range	Time	Temperature Degrees C.	Test No.	Per Cent Reduction	Temperature Range	Time	Temperature Degrees C.
B7	79.34		15 hr. 15 min.	280	B19	100		10 hr.	510
B8	100		41 hr.	280	B39	87	500	1 hr. 3 min.	510
B15	61.0		22 hr. 30 min.	280-290	B40	100	to	1 hr.	510
B16	16.0		6 hr. 40 min.	290	B48	50.0	600	20 min.	510
B17	46.0	280	23 hr.	250-270	B54	21.1		20 min.	510
B18	79.0	to	21 min.	280	B41	46.5		12 min.	595
B20	67.0	300	24 hr. 30 min.	280					
B26	69.0		35 hr.	280	B6	100		30 min.	670-700
B33	98.2		41 hr.	280-290	B22	100		30 min.	600
B36	85.2		35 hr. 45 min.	290	B28	100	600	15 min.	680
B55	20.2		12 hr. 20 min.	280	B41	46.5	to	12 min.	600
					B42	10.0	700	5 min.	600
B12	84.0		14 hr.	320	B45	100		5 min.	690
B13	95.0		7 hr. 50 min.	360					
B24	100	300	7 hr.	380	B37	100	700	15 min.	710
B27	100	to	10 hr. 10 min.	390	B35	100	to	15 min.	740
B26	69.0	400	12 hr.	335	B45	100	750	5 min.	710
B32	100		36 hr.	320					
B44	100		33 hr. 30 min.	390	B4	100	750	32 min.	760-780
B47	36.5		10 hr. 30 min.	390	B5	74.0	to	20 min.	780-800
					B43	100	800	5 min.	790
B10	100		8 hr. 30 min.	450	B46	35.2	to	3 min.	785
B11	100	400	6 hr. 40 min.	480	B9	100	850	1 hr.	850
B14	57.0	to	1 hr.	490	B56	100		3 min.	850
B21	100	500	8 hr.	400					
B23	100		3 hr.	480					

(average 1.8 μ) were carried off mechanically by the gas stream of hydrogen. As the reaction is a surface reaction, it is not possible to conduct the experiments other than with very finely ground stannic oxide. The percentage of the loss resulting through mechanical carrying off of the particles was lessened by doubling the size of the charges or by increasing the charge weight in a greater proportion. The average excess weight loss was less than 1 per cent.

Each point on the accompanying curves was obtained in a similar manner. At any one temperature a large number of tests was made, all factors except time being constant. Tests were made with gradually decreasing periods until the minimum time necessary for 100 per cent reduction of unit charges was determined. Results have been plotted separately in time and percentage of reduction for each temperature. A cross curve was then drawn through the minimum time necessary for 100 per cent reduction. The cross curves are those given.

Best Temperatures Above 750 Deg. C.

The curve for the results given in Fig. 2 covers the temperature range of 250 to 850 deg. C. In all tests the velocity of the hydrogen through the system was the same, and was in excess of that absorbed by the oxide, as was shown by the fact that the stream of hydrogen was kept sufficiently rapid so as to bubble continuously through the mercury seal at the end of the system. The curve for the reduction is logarithmic. The general expression was found to be: $\log T_k + \log M = C$. In this particular test where T_k is the absolute temperature and M the time in minutes, the expression takes the form $T^n{}_k M = C$. In this, $n = 10$ and the constant $C = 30.8$. Extrapolation of the curve shows that, under the conditions of the experiment, the reaction would be instantaneous at 1,000 deg. C., and would require about $8\frac{1}{2}$ days at 100 deg. C., assuming reaction possible at that temperature.

The shape of the curve shows that the most advantageous temperatures at which to operate are those above 750 deg. C., when rapidity of reduction is desired. When the curve for stannic oxide is plotted (Fig. 3) with a relatively small time interval as ordinate, the curve can be seen to have a distinct inflection at approximately 750 deg. C.

It was desired to determine the rate of reduction of ferric oxide in comparison with stannic oxide, in order to gain an insight into what happens in a complex ore containing iron and tin oxides together, as well as the oxides of the other metals. Pure ferric oxide was obtained from the J. T. Baker Company. The material ran 0.17 per cent volatile matter at 800 deg. C. Determination of its iron content showed it to be very pure. Kinnison[14] has shown that ferric oxide dissociates into ferrous-ferric oxide and oxygen at 1,350 deg. C. according to the equation.

$$6Fe_2O_3 = O_2 + 4Fe_3O_4.$$

In this particular investigation we are interested in the final summation reaction

$$Fe_2O_3 + 3H_2 = 2Fe + 3H_2O$$

and also in the curve of the reduction. All of the apparatus used for stannic oxide was used in that test also, with the exception that ferric oxide was substituted for stannic oxide. The hydrogen before purification (the product of the Shriver generator) analyzed over mercury: carbon dioxide, 0.2 per cent; carbon monoxide, 0.0 per cent; oxygen, 1.1 per cent; hydrogen, 98.7 per cent. After purification it analyzed practically 100 per cent hydrogen.

The time-temperature curve for the reduction of ferric oxide by hydrogen was plotted and is given in Fig. 2. As was the case with stannic oxide, the velocity of the reduction was not the same for all parts of the mass, being lessened and continuing greatest at those points first affected.

Discussion of Results

In shape, the reduction curve is the same as that for stannic oxide. The same expression, $T^n{}_k M = C$, holds good. The value of "n" is approximately 7.67 and of the constant "C," approximately 23.33, both of which

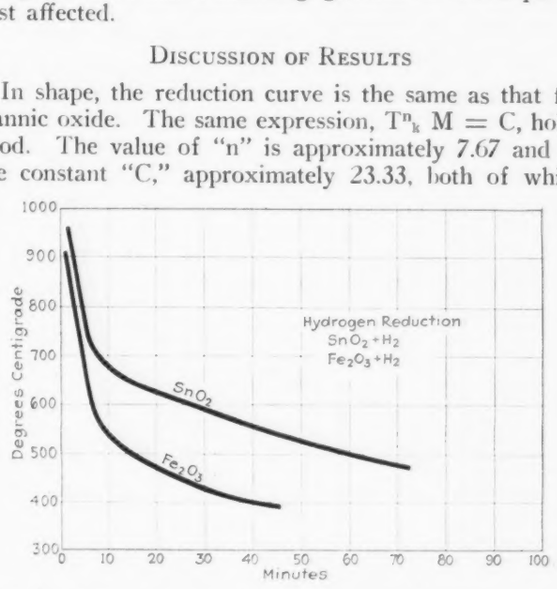


Fig. 3—Curve showing time necessary for complete reduction of stannic oxide and ferric oxide at various temperatures

are lower than the corresponding values for stannic oxide. For ferric oxide the curve is shifted over closer to the axes than is the stannic-oxide curve.

The conclusion is therefore drawn that ferric oxide reduction by hydrogen is easier than stannic oxide reduction by hydrogen. It would be assumed, therefore, that in a mixture of these oxides the tendency would be:

[14] *Trans.* Amer. Ceramic Soc., *16*, 136-143 (1914).

first, for a reduction of the ferric oxide; second, a stage where both were being reduced, the ferric oxide at a faster rate than the stannic oxide; and, third, a stage where all the ferric oxide was reduced with some stannic remaining.

It was thought that the size of the particles, with the resultant surface, would have an important effect upon the velocity of the reaction. Inasmuch as the velocities of stannic oxide plus hydrogen, iron oxide plus hydrogen, and the tin ore plus hydrogen, were to be compared, it was necessary to eliminate the error which might arise from different surfaces of the same weight of material. The tin concentrate had been received in sizes varying from a fine powder to particles as large as $\frac{3}{4}$-in. diameter. This was pulverized in a ball mill with flint stones. Comminution was continued (the ball mill was run about half full for 24 hours) until the tin ore was in the form of a very fine powder. The iron oxide and stannic oxide were finely powdered materials.

A determination of the size of the particles of these various substances was made. It can be assumed, with fair safety and as an approximation, that powders which have the same size of maximum particle will have about the same surface exposed to reductants. Stannic oxide, ferric oxide, and stannous oxide form the same type of particle when precipitated, dried, and ground in a ball mill.

A microscope with a micrometer eyepiece was obtained and used for this work. The micrometer eyepiece had previously been calibrated in respect to the height of the drawing tube, the eyepiece, and the objective. From this calibration the value in μ (1/1,000 of a millimeter) could be directly obtained.

Very small amounts of the different substances were placed on watch glass and so oriented under the objective of the microscope that a large number of particles could be measured individually. From the measurements made the following values were obtained. These sizes are the average of maximums:

Substance	Microns
Ground tin concentrates	1.6
Ferric oxide	1.8
Stannic oxide	1.8
Stannous oxide	1.5

Metallic iron resulting from the reduction of the iron oxide was also measured, and the size of its particles was found to be between 2 and 3 μ. Reduced tin particles varied between 1 to 2 μ when not globulated.

Conclusions

Reduction of tin oxide by hydrogen has been studied and shown to be rapid at 700-800 deg. C. The commercial possibilities of this method are many. Temperatures necessary are far below those used in tin smelters today. Future possibilities are indicated by the large-scale investigations now under way. The economic aspect will be discussed in a later paper. Our results, based on experiments over a wide range of temperatures, indicate practical commercial operations at from 750 to 900 deg. C.

Engineering—A Definition

By T. A. Rickard

THE publication of a bulletin (No. 190, October, 1927), by the Mining and Metallurgical Society of America, in which an answer is made by a large number of mining engineers to the question 'What is Engineering' prompts me to discuss this serious effort to define a word that is of special significance to the profession. In doing so, I am reminded of the lively controversy over the definition of 'ore' in 1912 and 1913. The critical idea was that 'ore' is mineral that is mined to economic advantage.[1] The definition of 'engineering' suggested by a committee, appointed for the express purpose of clarifying our ideas on the subject, follows:

"Engineering is the practical application of scientific methods to the utilization of the resources of nature for the use of man."

In attempting to define a word it is advisable not to use words that themselves need to be defined. We do not succeed in defining an arch-deacon, as Swift did, by stating that he performs archidiaconal functions. What is "practical"? It refers to the doing of things, in contrast to the mere thinking of them; it applies to a habitual way of doing things; 'practical' is an epithet inappropriate to our purpose; a man may design an efficient and competent bridge without ever building one himself or superintending the construction of one. Such a man, nevertheless, would be an engineer, would he not? An architect may plan a house without having anything to do with the subsequent realization of his design. Next we have the word "scientific"; which also, in this context, needs to be defined. To drive a tunnel for the purpose of intersecting a vein is a work of engineering, but is it 'scientific' in any special sense? Undoubtedly it is such in the broad sense of Huxley's description of science as "organized common sense", but that also would apply to the simple tasks performed by uneducated laborers, engaged, for example, in shoveling and tramming ore underground, a performance that I presume would not be included under 'engineering', nor would it be labeled 'scientific'. Here I may remind my readers that mining, like metallurgy, is an 'art', not a 'science', although the latter term is commonly applied to both these phases of human activity. An 'art' is a skilful way of doing things; 'science' is systematic knowledge. When exploiting ore deposits we apply the sciences of geology, physics, and mechanics to the art of mining.

Next, the inclusion of the ethical idea that such work is done for the use or benefit of man introduces a thought that like "the flowers of spring" has "nothing to do with the case." It is incorrectly restrictive. In the same way many people would define 'taste' as "an appreciation of the good and the beautiful", whereas, of course, such ideas are by no means implicit. 'Taste' is a sense of what is fitting. A person may lack an appreciation of goodness and yet be possessed of extraordinary good taste. Stanford White, whom Thaw killed, was a man of loose morals, as judged by the conventional standard, but, as an architect, he exhibited exquisite taste. A bad man may have good taste. Likewise in our definition of engineering, we must not limit its performance to beneficent purposes. A man that builds a bridge to facilitate the passage of a battery of artillery for the purpose of killing people on the other side of a river has performed a feat of engineering. To plan and dig a tunnel for the pur-

[1] *The Mining Magazine*, 1912 and 1913.

pose of undermining an enemy's position, and of blasting the soldiers stationed there, does not contribute to the welfare of man; to design a gun that will drop explosive shells on the churches, hospitals, and schools of a populous city is distinctly a feat in military engineering, however maleficent it may seem to us, and however detrimental it may be to the well-being of mankind.

An amended definition omits the "practical" and "the use of man", but retains "scientific". But, as others have pointed out, such a definition is too comprehensive; it includes the work of a score of human occupations in all of which natural resources are utilized by means of more or less systematic procedure. Moreover, the definition is too narrow because it excludes surveying, which is a branch of engineering, but itself does not always serve to utilize natural resources; it excludes testing of all kinds, although this is an important adjunct of engineering. Likewise a negative report as to the applicability of a technical process or the worthiness of a plan of construction does not come within the limits of the proposed definition, although obviously within the scope of engineering practice. A definition should include all that belongs to the category of things to be defined, and at the same time it should exclude the things that do not belong to that category.

It is curious that among the many definitions suggested, not one has been based upon the derivation of the word 'engineering'. This comes to us from the Latin *ingenium*. Engineering is an ingenious way of doing things; a manner of doing them that exhibits skill in contriving. The difference between a laborer and an engineer is that the one does what he is told and the other says how it is to be done; the engineer contrives a skilful way of doing the task. Sir Walter Raleigh, writing concerning the crude methods of winning gold in Guiana in 1595, says that the operations of the natives were *opus laboris, non ingenii;* they used labor without ingenuity, they tired their muscles in unintelligent toil because they were incompetent to devise methods that would have made their work easy and efficient. They lacked the engineering sense. Ingenuity is the essence of engineering. Our definition must rest on that concept. Therefore, I suggest: *Engineering is the application of ingenuity to human handiwork.* The last word is preferable to 'labor', 'toil', or 'effort', because it restricts the performance to work done, or things made, by the hands; therefore it excludes the purely theoretical, but it includes the designing of a bridge or the planning of a mill, because these exercises of the brain are intended to be applied, and with ingenuity, to the handling of materials. To think that 'engineering' can be confined to the work of the profession is as unreasonable as to suppose that the function of thinking is the special prerogative of the philosopher, that the task of building belongs only to the architect, or that the operations of agriculture are the monopoly of the farmer. By the same token the design of a harvester and the planning of the draining of a tract of land are alike engineering. The term must include a great variety of human activities, and if we wish to specify any one of them in particular we must qualify our definition as the case demands. Thus mining engineering is the application of ingenuity to the work of mining; mechanical engineering is the application of ingenuity to the making of machines and to the use of them; military engineering is the application of ingenuity to the use of war material. A ship-load of water melons was being removed to a warehouse on a wharf; the melons were carried one at a time by a gang of men, until the chief stevedore suggested that they stand in line and pass the melons from hand to hand. That was engineering sense, just as much as the invention of a bucket chain, a traveling belt, or a grain elevator. Nor is engineering wholly confined to the operations of man; in a special sense the work of the beaver in constructing his dam, the work of the bee in forming the cells for his honey, the labor of the bird in building his nest is 'engineering', so far as each of these illustrates the application of ingenuity to effort. However, in defining 'engineering' we are doing so in terms of human activity, for in these, as in other matters, we have the habit of considering man as the center of our universe. On the other hand, the use of 'engineering' in the sense of scheming, as in the statement that somebody "engineered" a deal or a promotion, is unacceptable, because the performance, although it involves ingenuity, does not apply to human handiwork, but only to financial legerdemain.

Any effort to restrict 'engineering' to the work of our profession, or to the allied professions of the mechanical, electrical, and chemical engineers will fail so far as it will be rejected by persons outside these professions. I am reminded of the attempt to distinguish between mining and oil-getting, a discrimination expressed by the phrase "mining and oil", to cover the industries in which variously stony minerals and a liquid mineral are exploited. The winning of oil, of course, is a phase of mining; the liquid condition of petroleum does not exclude it from the category of minerals any more than the dissolving of salt, to pump it to the surface from an excavation underground, causes it to become either animal or vegetal. The pumping of gold-bearing gravel and the raising of sulphur by means of superheated steam are mining operations. Mining is the art of exploiting mineral deposits. The idea of gain is implicit, for one does not exploit them for one's health nor to improve the scenery of the waste places of the earth. A mineral may be dug out of the ground, or pumped out of the ground, or allowed, by openings made artificially, to be pumped by its associated gas, or liquified by heat before being pumped, or dissolved by cold water, for the same purpose; in each case the operation is included under 'mining'; and in each case the application of ingenuity brings it within the scope of 'engineering'.

It is the rightful boast of the engineer that he has lightened human toil by the introduction of machines and methods that have enabled man to control the forces of nature and harness them to his service; the steam-engine has become the universal drudge by whose intervention the workman is released from needless effort; the use of skilful contrivances has mitigated industrial slavery and quickened human accomplishment. Engineering is the genius of our material civilization.

Nova Scotian Salt Mine Developed for Fisheries

In 1917 rock salt was discovered at Malagash, Nova Scotia, and the first production from these deposits was made two years later. The importance of this discovery to the fisheries of the Maritime Provinces of Canada was early recognized and steps were taken to produce grades of salt suitable for the curing and packing of fish. Development of these deposits has progressed steadily from a production of 174 tons in 1919 to over 8,000 tons in 1926, says L. H. Cole in *Natural Resources, Canada.* The salt from these deposits is won by mining at a depth of 85 ft. from the surface, after which it is ground.

Automatic Equipment for Reclosing and Sectionalizing

By A. E. ANDERSON
Switchboard Department, General Electric Company

AUTOMATIC CONTROL has been widely applied to the mining field. Not only has it been used in connection with conversion and distribution apparatus, but it has also been successfully applied to hoists, pumps, and battery-charging equipment. A few features concerning the latter application are given in the following paragraphs.

Some time ago the Inspiration Consolidated Copper Company found it necessary to provide an additional ore hoist. Based on experience of over ten years with a certain type of automatic hoist, it was decided that the new application should be automatic also. In addition to obviating the services of hoisting engineers, the man and material hoists have certain safety and protective features.

The new hoist is automatic, is electrically operated and handles two 12-ton skips in balance, raising 600 tons per hour. The total maximum lift is 1,485 ft. There are also two other levels of 1,330 and 1,025 ft.

When changing from operation at one level to operation at another, the skips are first brought to the proper level, after which the control is transferred for operation at the desired level. The hoist is adjusted for operation, after which the loader may start the hoist by closing a master switch. From this point to the end of the trip the operation is entirely automatic, excepting for certain emergency features.

In connection with mine pumping, because of the high cost of attendance in the main pump rooms, it was found desirable to develop a method which permitted the pumps to run unattended and yet properly protected. The reliability of such equipment is particularly noteworthy in view of the average of from ten to fifteen tons of water pumped for every ton (of coal) mined. Installations using pumps driven by 650 hp. motors are in successful operation.

Another interesting application of automatic control is in battery charging. A panel has been designed for mining service which not only gives the desired charging rate, but which, because of its construction, can be readily moved from one place to another with a minimum of installation work.

The development of application of automatic control to mining substations has covered a number of years. An increasing number of applications indicates a ready appreciation by the mining industry of the advantages of this type of equipment. Both motor-generator sets and synchronous converters are being successfully controlled.

It is usually desirable to place substations for automatic control on the surface, as they are likely to receive better attention there. However, there may be certain advantages in locating a substation underground, under which conditions an automatic substation can be located near the working face. This allows shorter runs of feeder as well as effects a saving in the wages of one or more operators. The reduction in the quantity of feeder copper is sometimes enough to offset the extra cost of making the station automatic.

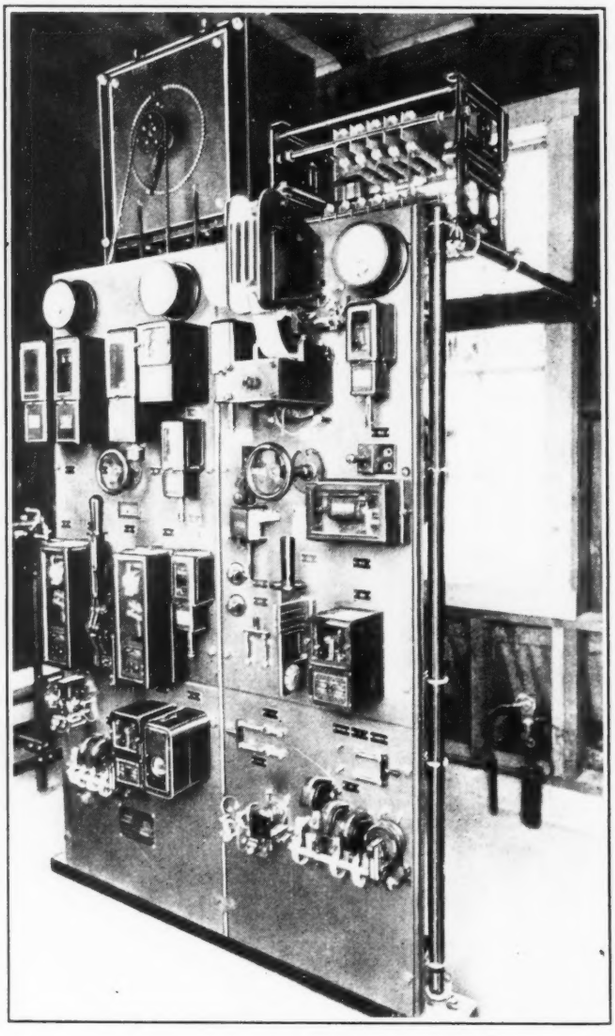


Fig. 1—Automatic control devices for 250/275-volt d.c. 150-kw. synchronous motor-generator set with d-c. automatic reclosing stub-multiple feeder. Installation at Inspiration Consolidated Copper Company, Inspiration, Arizona

Operating experience has shown that the quality of

service given by an automatic substation is superior to that given by the average manually operated station, and is at least equal to the best. Not only is the voltage improved at various parts of the system, but the number and length of interruptions also are reduced.

The machine is started automatically by a suitable master element, which may be in the form of a small lever switch. As soon as proper voltage conditions have been established on the direct-current end, the machine is in readiness to be connected to the load circuit through a reclosing feeder. Fig. 1 illustrates the devices necessary for automatic control and protection of a 150-kw. 250/275-volt, direct-current motor-generator set. At the right is shown the automatic reclosing feeder for this set.

Stub and Multiple Feeders

There are two main classes of application for which reclosing feeders are used. These depend not only on the manner in which the machine is connected to the direct-current network, but also on the method of sectionalizing the network.

A stub or radial feeder is one which connects a load to a single source of power. This type of feeder is shown diagrammatically at the left in Fig. 2.

A multiple feeder is one which may be connected to a load in common with other feeders which are usually from independent sources of power. This type of feeder is shown at the right in Fig. 2.

In mining work several generators or converters may serve the mine during the day. At night, however, one such machine is usually sufficient to supply the cutting machines, pumps, lights, and other incidental devices or machinery. In such applications a single feeder may be required to operate on either stub or multiple feed. Such a feeder is known as a stub-multiple feeder and is the most frequently used. The upper right panel in Fig. 1 illustrates this type of feeder. As mentioned below, this type of feeder uses a selective control relay which automatically changes the feeder for operation on either stub or multiple feed. In this manner the reclosing characteristic is adjusted to give the proper operation for the particular load condition.

Reclosing Feeder Characteristics

The most common method of determining the conditions of the external circuit on stub feed is by the use of a load-indicating resistor. This resistor usually limits the measuring current to a maximum of a few per cent of the feeder rating. When the load resistance has increased to a predetermined value, this small value of current will produce sufficient voltage across the load circuit to operate the reclosing relay.

On multiple feed, the feeder is reconnected when the voltage difference between the bus and feeder is low enough to prevent an excessive current from flowing when the line contactor is reclosed. These features are discussed in more detail in subsequent paragraphs.

Load-limiting resistor feeders have had their principal application to railway loads. They have had a very limited application to the mining field, and are used only when characteristic traction load is to be handled. The purpose of the load-limiting resistor is to enable the machine to carry over peak loads by inserting a step of resistance having a relatively low ohmic value. With the type of mining load ordinarily encountered it is found that the use of a load-limiting resistor will aggravate conditions rather than relieve the overload.

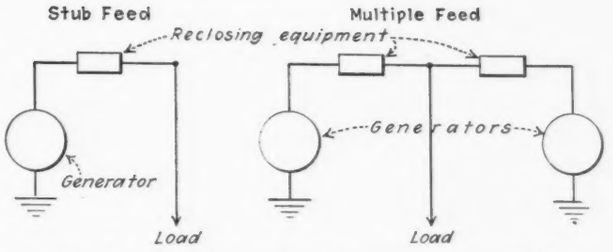


Fig. 2—Feeder circuits shown diagrammatically

An automatic reclosing feeder should possess the following characteristics:

1. It should trip on overcurrent.
2. It should reclose after a time delay.
3. It should reclose when load conditions become normal.
4. The tripping, time delay, and reclosing values should have independent adjustments.
5. The stub- and multiple-feed adjustments should be independent.

These points are covered in more detail in the following paragraphs. The devices are refrred to by function numbers which are based on a system standardized by the Electric Power Club[1] and adopted by the General Electric Company. This system is applied to the panels by means of small name plates near the particular device and also appears on the wiring diagrams and in the instruction books.

Because automatic reclosing feeders operate to restore service with a minimum time delay, it is customary to set the over-current relay at a lower value than is possible with manually operated equipment. A series-overcurrent relay, No. 176, is used with the reclosing feeders.

A time-delay relay, No. 102, is used to permit load conditions to become stable. This relay keeps the feeder open a minimum definite time, regardless of external circuit conditions. This time delay enables the short circuit or overload to be removed and permits rotating machinery to come to rest.

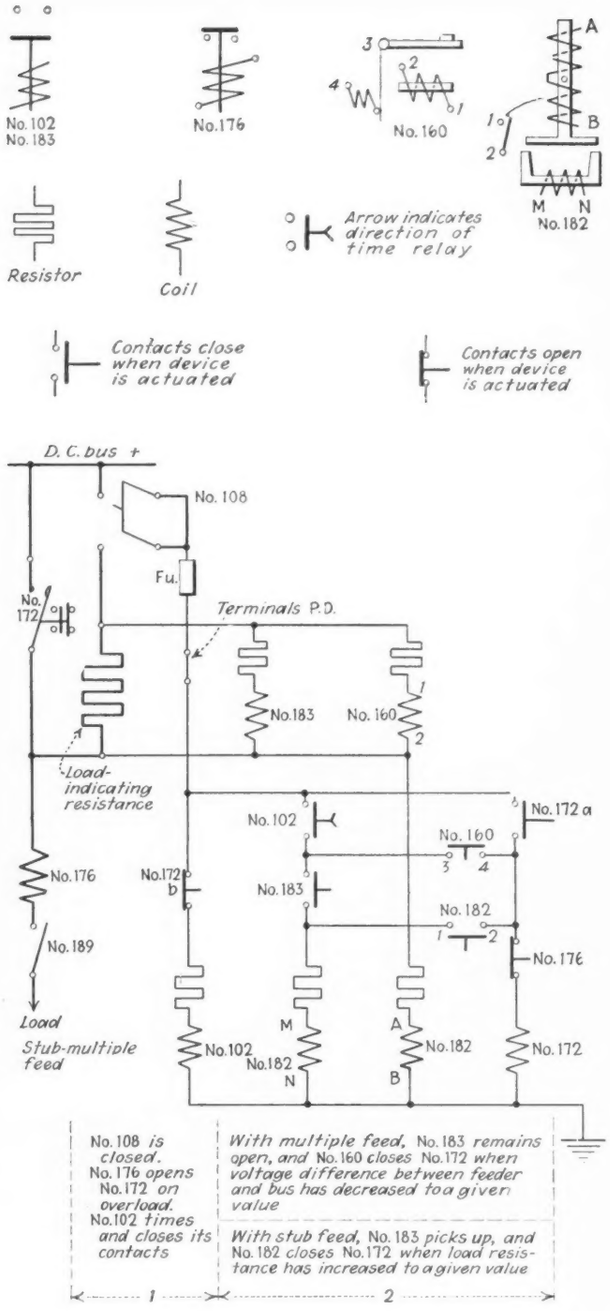
As mentioned above, the stub-multiple feeder is most frequently used. This type of feeder is provided with two reclosing relays, one for stub feed and another for multiple feed. A selective control relay, No. 183, determines which relay is to function.

The stub-feed reclosing relay, No. 182, may be set to allow reclosing over a range of values up to the feeder rating. By the use of a certain design of relay connected as shown in Fig. 3, the equipment will not reclose on a short circuit, even though the supply voltage varies between wide limits.

The multiple-feed relay, No. 160, has a voltage equalizing function. In other words, it will not permit the breaker to close unless the voltage difference (between the bus and out-going feeder) is less than a predetermined value. The load which will be picked up on multiple feed depends on the voltage difference between the circuits, the feeder and return circuit resistance, and the amount and location of the load with respect to the substations.

By the use of a separate device for the functions (Nos. 102, 160, 176, and 182), as mentioned above, it is possible to obtain independent adjustments. It is apparent that one relay cannot readily perform the proper reclosing function for both stub and multiple feed, as the

[1]The Power Club is now the "N.E.M.A." (National Electrical Manufacturers' Association).



P.D.	Protective devices
Fu.	Fuse
b	Auxiliary switch, closed when main switch is open
a	" " open " " " " "
No.189	D. C. line switch
No.183	Selective control relay
No.182	D.C. reclosing relay
No.176	D.C. overcurrent relay
No.172	D.C. line contactor
No.160	Voltage equalizing relay
No.108	Control power switch
No.102	Time-delay closing relay

Fig. 3—Elementary circuit diagram of stub-multiple reclosing feeder

stub-feed condition is essentially one of measuring the load resistance, whereas the multiple-feed condition is one of paralleling the machine on a circuit already made alive by a remote source. In one instance (stub feed) the feeder voltage is a few per cent of normal, whereas in the other (multiple feed) it is very close to normal.

A stub-multiple feeder will operate on either stub or multiple feed. The principal steps in the sequence of operation are as follows:

1. The feeder is automatically disconnected from the power source when the load exceeds a predetermined value or the voltage fails.
2. No attempt is made to reclose until load conditions are normal and sufficient operating voltage is available.
3. The feeder remains disconnected for a short time (usually 30 seconds) regardless of line conditions.
4. Reclosing equipment automatically determines whether the feeder is operating on stub or multiple feed, and functions accordingly.
5. The feeder is reclosed (after the above time delay) as soon as the excessive load is removed.

The legend in connection with the elementary diagram in Fig. 3 outlines the method of operation in a brief manner. Sequence of operation takes place from left to right in this diagram. A more detailed description of operation is given in the paragraphs immediately following.

It is assumed that the control power switch, No. 108, and the direct-current line switch (No. 189 is used), are closed, and that the feeder is in service. The overcurrent relay, No. 176, will open its contacts when a predetermined value of overload occurs. Opening of the contacts of No. 176 de-energizes the coil of direct-current line contactor No. 172 and disconnects the feeder from the bus. Current then flows through the load-indicating resistor into the short circuit or overload.

As soon as contactor No. 172 opens, its auxiliary "b" switch closes and completes a circuit from the positive bus through the control power switch, No. 108, the "b" switch on No. 172, coil of No. 102, to the negative bus. Relay No. 102 closes its contacts after approximately 30 seconds. This interval permits the feeder-load conditions to reach a steady value.

The feeder will usually be connected in multiple with one or more sources of power, but if all these sources are dead, except the one connected to the reclosing feeder in question, the feeder is operating on stub feed and the reclosing equipment will operate as such.

The selective control relay, No. 183, differentiates between the type of feed existing at the time the equipment is reclosing. It is connected across the load-indicating resistor which is in series with the machine and load when the line contactor, No. 172, is open. Under stub-feed conditions, the voltage drop across the load-indicating resistor will be high, because the resistance of this portion of the circuit is large compared with the resistance of the load. Relay No. 183 will be sufficiently energized to pick up, thus indicating stub feed.

Under multiple-feed conditions, the voltage of the feeder is more nearly that of the station, and consequently the voltage drop across the load-indicating resistor is smaller and is the difference between the bus potential and the feeder potential. The selective control relay, No. 183, will not be sufficiently energized to pick up and will, therefore, indicate multiple feed.

Reclosing on Stub Feed

If the selective-control relay, No. 183, has picked up, indicating stub feed, the reclosing of the feeder will be directed by the reclosing relay, No. 182.

The load-indicating resistor is connected across the contactor, No. 172, to permit a small measuring current to flow when the line contactor, No. 172, is open. To determine the value of the load conditions after contactor

No. 172 opens, the resistance of the feeder circuit must be measured, as the load will be inversely proportional to this resistance. If the resistance is high, the load will be light; if the resistance is low, the load will be heavy, when No. 172 is reclosed. To measure the resistance of the load, a small current (a few per cent of normal) is allowed to flow into the load. This value of current is determined by the load-indicating resistor. The potential drop across the load is measured by the upper or A-B coil of the direct-current reclosing relay, No. 182. The voltage impressed upon the upper coil is thus approximately proportional to the resistance of the load. If the resistance of the load is low, the voltage drop across the upper coil of the reclosing relay, No. 182, will be sufficient to actuate the relay, but if the load or feeder resistance is high enough to prevent the feeder from being overloaded when it is connected to the bus, the upper coil of reclosing relay No. 182 will be sufficiently energized and, in conjunction with the lower or M-N coil, will close the contacts of the relay. The contacts of the reclosing relay, No. 182, complete a circuit from the control power switch, No. 102, through the contacts of No. 102, No. 183, No. 182, and No. 176, to energize and close No. 172. When No. 172 closes its "a" switch, a "holding-in" circuit is completed around the contacts of No. 102, No. 183, No. 182, and No. 160. The contactor opens its "b" switch an instant later, which deenergizes the coil of No. 102, and thus causes the contacts of the latter device to open. The load-indicating resistor coils of No. 160 and No. 183 are short-circuited by the closing of No. 172.

Reclosing on Multiple Feed

If, as has been previously mentioned, the voltage drop across the load-indicating resistor is relatively small, which is the case in multiple feed when some other machine is supplying potential to the feeder, the selective control relay, No. 183, will not be sufficiently energized to close its contacts. The reclosing relay, No. 182, cannot close the line contactor, No. 172, so the reclosing of the latter device will depend on the voltage-equalizing relay, No. 160.

The coil of No. 160 is connected across the line contactor, No. 172, and measures the voltage drop across the contacts when the contactor is open. This relay is set to close its contacts when the difference in voltage between the bus and the feeder is low enough to prevent an excessive current flowing when the line contactor, No. 172, is reclosed.

Closing of No. 160 completes a circuit from the control power switch, No. 108, through the contacts of No. 102 and No. 160 and the contacts of the overcurrent relay, No. 176, to energize and close No. 172.

The action of these devices after line contactor No. 172 closes is identical with that which takes place when No. 172 is closed under stub-feed operation.

Purpose and Operation of Devices

Device No. 102 is the time-delay closing relay. The time delay furnished by this relay allows the load conditions to become settled or steady. The relay can be adjusted to close at any value of voltage from 70 to 110 per cent of normal. Though the time delay can be adjusted from practically zero to 30 seconds, it has been found that settings of over 15 seconds are desirable, and the most common setting is 30 seconds. The setting of No. 102 should permit all rotating apparatus on the feeder circuit to come to rest. Sufficient counter electromotive force may be obtained from shunt motors to give the indication that the feeder circuit is normal when actually it is overloaded. After the above time delay has expired all counter emf. will be attributed to resistance or "deal load," as it is sometimes called. This condition of the circuit makes it possible to predetermine the reclosing current readily.

Device No. 108, the control power switch, is of the double-pole, single-throw type. The circuit to the control devices is interrupted by one pole. This same pole, in series with the second, opens the load-indicating resistor circuit, giving two breaks in series. No. 108 should be opened before, or closed after, No. 189.

Device No. 160, the voltage-equalizing relay, functions on multiple feed. It permits No. 172 to reclose when the difference of voltage between the bus and feeder has decreased to a predetermined value. This device has a calibrated range of from 25 to 150 volts.

Device No. 172 is the direct-current line contactor which is held closed magnetically. This type of circuit interrupter is designed principally for industrial and mining application. It covers the range of voltage and current ordinarily encountered in this field. The purpose of

Fig. 4—1,500-amp. contactor of type used with reclosing feeders, interrupting over 16,000 amp. at 550 volts d.c. on an inductive circuit

the contactor is to disconnect the feeder from the bus in the event of overload. This is accomplished through the operation of the overcurrent relay, No. 176, which deenergizes the coil of No. 172.

No. 172 is equipped with one coil, which gives the desired closing and holding action. No change is made in the connection of this coil between the closing and holding operation. Consequently, the coils are not affected by frequency of operation. They will stand continuously any voltage from zero to 110 per cent normal. The contactor will close at 80 per cent normal voltage. Once closed it will remain in this position until a minimum of 25 per cent normal voltage is reached.

The type of contactor used with this equipment is well adapted for frequent interruptions of heavy current. Fig. 4 shows the 1,500-amp. contactor breaking over 16,000 amp. on a 550-volt inductive circuit. The arc-interrupting device of this contactor has been found to be so successful that it has been applied to another type of current interrupter, and, in this particular design (for

railway service), has successfully interrupted 48,000 amp. at 550 volts.

Device No. 176 is the direct-current overcurrent relay. As ordinarily furnished, this device operates instantaneously whenever the load current exceeds the value for which the relay is adjusted. The relay is generally calibrated over a range of from 70 to 250 per cent of the feeder rating.

Device No. 182 is the direct-current reclosing relay which functions on stub feed. It permits No. 172 to reclose when the feeder resistance is of a predetermined value or greater. The characteristics of the relay are such that overvoltage conditions will not cause it to close the feeder on excessively heavy overloads. The relay is calibrated in amperes and can ordinarily be adjusted to reclose No. 172 under load conditions which will limit the flow of current to a maximum of 25, 50, 75, or 100 per cent of the feeder rating.

Device No. 183 is the selective-control relay. This relay determines whether the equipment is to operate on stub or multiple feed.

Device No. 189 is the direct-current line switch. Although this device is optional, it is best for most installations. It provides a means for isolating the equipment from the feeder circuit. No. 189 should be opened or closed only when devices No. 108 and No. 172 are in the open position.

(To be concluded)

Copper Construction for Bank Vaults Advocated by Research Association

PERFECTION of a new type of bank vault that is immune to burglar attack as a result of the use of copper in construction was recently announced by the Copper and Brass Research Association. According to the association, exhaustive tests just completed show that the oxy-acetylene torch, recognized by safe experts as the most powerful instrument of vault attack, requires approximately two hours to penetrate a plate of pure copper seven inches thick.

In commenting on the significance of these tests, the association points out that a vault burglar would require about six hours of uninterrupted effort with the oxy-acetylene torch to penetrate a modern vault door twenty inches thick, containing a twelve-inch plate of pure copper.

"The high resistance of copper to torch attack," says the association, "is explained by the fact that this metal is a rapid conductor of heat, in contrast with other metals of low heat conductivity heretofore used in vault construction. A torch capable of developing a heat between 5,000 and 6,000 deg. F. will penetrate the first few inches of a copper plate in a comparatively short time. However, the flame loses its efficiency as the copper conducts the heat rapidly away before the entire body of the metal can be raised to a fusing point, and the torch becomes ineffective."

As an indication of the importance that bankers, architects, and vault engineers attach to this latest development in vault construction, the association points out that the vaults of the largest bank in Asia, the new $14,000,000 Mitsui Bank Building, in Tokyo, will be protected by specially designed massive doors containing copper plates.

DISCUSSION

Four-Year Performance of a Four-Mile Belt Conveyor

THE EDITOR:

Sir—Under the caption "A Gigantic Belt Conveyor" in *Engineering and Mining Journal* for Jan. 31, 1925, I briefly described the 4⅓-mile conveying system at the Colonial group of four coal mines of the H. C. Frick Coke Co., at Scottdale, Pa., about 50 miles from Pittsburgh. During a visit of the Coal Mining Institute of America three years ago I saw the installation, and at a joint meeting of the A.I.M.E. and Engineers' Society of Western Pennsylvania, held at Pittsburgh on Oct. 20, 1927, the performance of this conveyor was described in a paper by T. W. Dawson, chief engineer, and read and illustrated with pictures by the assistant chief engineer, E. C. Auld. This paper will appear soon in the *Proceedings* of the Engineers' Society, whose secretary approves of my sending in these notes.

Actually, this conveyor consists of 20 motor-driven sections, 22,930 ft. in length. The first section inside the mine under the feeding bins is 6 ft. wide and the other sections are 4 ft. wide. The total lift is 353 ft. The conveyor started work in April, 1924, and results may be shown in this manner:

Total coal carried, tons	9,390,619
Record month, March, 1927, tons	298,047
Record day, Jan. 5, 1926, tons	13,866
Total delays of more than fifteen minutes each	50
Total period of delays, hours	45¾
Accidents to belt attendants	Three minor.
Belt splices (formerly clipped)	All vulcanized.
Original belt in service, per cent	57
Replacement of idlers or carriers	100
Prevention of clogging of chutes from one belt to another	By flappers which can cut off the power.
Breakage of coal tests (length of one belt):	
(1) Carton of 12 eggs on top of coal	None broken.
(2) Carton of 12 eggs buried in coal	One broken, one cracked.
Pulleys:	
Original face	¾-in. crown.
New face	Flat.
Reason for change	With ¾-in. crown the circumference is 4.7 in. greater than at the rim. This stretches the center of belt which is strained and wears out sooner.
Results of change	Better running and longer life.
Economics of underground belt conveyors:	
Compared with surface trains	Cheaper operation.
Compared with surface conveyors	More expensive to install.
Minimum load for belt conveyor, tons a day	8,000
Operating capacity	Continuous full load.
Sinking fund charges, maximum	6c. per ton on 20-year life.

The conveyor is of Stephens-Adamson Manufacturing Company make, driven by General Electric Company motors and Falk reduction gear.

At a group of six mines at Palmer dock the H. C. Frick Coke Company is now installing a belt conveyor 15,280 ft. long with a total lift of 280 ft. to deliver 12,000 tons a day.

As stated in my first notes, these facts may be of interest to metal-mine operators. Of course there are short belts at Western plants carrying larger quantities of ore—at the Utah Copper Company's mills for instance—but there is nothing approaching these coal belts in size.

Pittsburgh, Pa. M. W. VON BERNEWITZ.

Better Business Bureaus

THE EDITOR:

Sir—I have read with interest in the current issue of the *Engineering and Mining Journal* your editorial on the need for setting up facilities to develop unprejudiced facts regarding mining projects for the information and guidance of small investors. For a number of years Better Business Bureaus throughout the United States have been rendering educational and protective services to the public. Last year, owing to the increasing volume of inquiries on mining projects, we undertook to enlist the co-operation of mining officials, inspectors, and geologists in the mining sections throughout the United States and Canada with a view to accumulation of authoritative facts. These officials not only promised whole-hearted co-operation, but have unstintedly given it when requested. They form one group in the more than one thousand active contacts which we have in the United States and Canada, in addition to the local Better Business Bureaus. We should also be remiss if we did not stress the unfailing courtesy and attention given our inquiries by the staffs of technical journals, including your own.

As Better Business Bureaus are disinterested fact-finding organizations, formed and operated not for profit but solely in the interest of the investing and purchasing public, we believe we are functioning as outlined in your editorial, and should be pleased, if consistent with your editorial policies, to have these facts set before your readers.

W. H. MULLIGAN,
Mgr., Financial Department,
National Better Business Bureau.

New York City.

* * * *

Capital for Swindles or Legitimate Enterprise?

THE EDITOR:

Sir—Your trenchant comment on the Julian Pete swindle, in *Engineering and Mining Journal* of Oct. 8, was a concise summing up of a disgusting situation, and my only criticism, if any, would be that you were perhaps too mildly temperate in your choice of words. But really aren't we humans a prize lot of boobs? Now if Mr. Skygack, a visitor from Mars, were to appear on the scene he would reason thusly: That inasmuch as the whole world and all its relatives know who did the dirty work, the logical and only method of procedure would be that the authorities would send out the patrol wagon and round up the malefactors and bring them before the court, where the judge would spend about 40 minutes in arraigning and sentencing them to 80-year terms in state's prison.

But no; for us nothing so simple and logical and straight to the mark. We must spend months of time dickering and conferring with the wretches; we must employ 47 "prominent attorneys," each of whom has got to be paid at least $5 a minute for his time; we must call 757 witnesses in a huge buck-passing contest, a gigantic effort to shift the blame from Tom, Dick, and Harry and finally trace it all down to the flea that bit Harry's bull pup. And the final result of all the flood of froth and the clouds of foggy language will be the recovery for the benefit of the stockholders of a net sum of about $11.17. Any "bright youngster" who wishes to peddle a couple of truckloads of spurious stock is left unmolested while he dishes it out to the "dear people" as fast as a battery of clerks can fill in the blanks.

California and the neighboring states have produced billions of dollars' worth of the precious and commercial metals, and today they are just speckled with partly developed mines needing only the magic help of money to start them pouring out streams of new wealth. The large sums of money thrown into the bottomless bog of the Julian Pete swindle would have completely equipped a hundred new mines and have given a wonderful impetus to the whole intermountain and desert region.

L. A. MASON.

Beatty, Nev.

* * * *

Is the Mining Industry Facing a Deficiency of Trained Engineers?

THE EDITOR:

Sir—On page 724 of *Engineering and Mining Journal* for Nov. 5, paragraph 4 particularly, of the article entitled "America Must Prepare to Meet the Industrial Challenge of Europe," causes me to wonder, in common with others, what may be one of the underlying reasons why the mining industry should be facing existing conditions and "functioning in a fashion so imperfectly." There is no doubt that this great basic industry is not receiving its due share of the prosperity of the country.

I venture to offer my opinion of what seems to me to be one cause of the difficulty, when I state that the industry does not appear to be taking its former quota of technically trained mining men.

In the official report of the American Institute of Mining and Metallurgical Engineers for 1926, presented at the annual meeting last February, the following statement was given: " . . . mining does not now attract the inflow of recent graduates from the technical schools that the other branches frequently do. The enrollment in engineering schools in the United States in 1925 and 1926 was approximately as follows: Electrical engineering, 18,200; civil engineering, 12,500; mechanical engineering, 10,700; mining and metallurgy, 2,100."

Reduced to percentages these figures show, E.E., 42 per cent; C.E., 29; M.E., 24; E.M. and Met. combined, 5 per cent. (Probably E.M., 3½ per cent and Met. 1½ per cent.) These figures are surely significant of the present trend of technical education, as far as the branches considered are concerned.

Why should this tendency exist? As I see it, there are at least two possible reasons: first, the mining industry may not be recruiting technically trained men to the same degree as formerly; second, the E.E., C.E., and M.E. industries are in large degree self-advertising, and young men with engineering aptitudes, seeing the products of these industries on every hand, are naturally attracted thereby. It is equally true that mining and metallurgical industries are not so conspicuous, being limited to so-called mining districts—sometimes rather remote—and localized metallurgical centers.

It would seem, therefore, that many young men fail to realize that the more attractive industries are absolutely dependent upon mining and metallurgical products, and that they as engineers should have a greater share in these great basic industries. It is quite apparent that graduates in the more attractive branches are fast entering fields which are likely to be over-supplied if the present tendency is continued.

Mining of necessity demands a greater breadth of training than any of the other industries, and though it is true that the training may not require as much specialization in certain lines, nevertheless a mining engineer is the most widely trained type in the land today, and few professions offer more varied, interesting, and profitable experiences.

With technically trained mining engineers employed in this industry to the same extent as in the others, both in research and in every-day problems, it is readily conceivable that much of the present difficulty of the mining industry could be on a fair way to solution.

HOWARD ECKFELDT.

Lehigh University, Bethlehem, Pa.

* * * *

New Barium Sulphate Process

THE EDITOR:

Sir—A new process for the extraction of practically pure barium sulphate from the various barytes ores is commanding an unusual amount of interest. It depends on the property of molten sodium chloride of dissolving and holding barium sulphate in solution to the exclusion of other minerals present in the ores treated. The barium sulphate is then separated from the salt by the simple operation of dissolving out the salt in water, which leaves a pure and incidentaly white precipitate and in the finest desired physical form. This results in a product that can hardly be otherwise than what the market has always required, but which was hitherto unobtainable commercially.

All of the tests made with various ores, and including those generally classified as "off color," yield uniformly good results and a product finer and whiter than has yet been produced by any other process. Incidentally, no grinding, acid treatment, nor any other operations are required on the product after precipitation, washing in clean water and drying. Estimates on the cost of production indicate a considerable saving over other methods of producing finished barytes of inferior grades.

It is expected that this process, applied to commercial production on a large scale, will have a far-reaching effect on the trade, as it will practically equalize the values of all barytes ores of equal barium sulphate content, regardless of the character of impurities. The value of the degree of purity and of the whiteness of the product needs no emphasis, and the form of the particles, which are globular, is far more to be desired than the sharp particles resulting from crushing and grinding, particularly when used as a filler for mechanical rubber. All these qualities are incidental to the process and do not result from any special treatment.

EDWARD DOTY, President,
R. K. Miller Minerals Corporation.

New York City.

* * * *

What Is an Engineer?

THE EDITOR:

Sir—Regarding the discussion of the definition of "Engineering" in your issue of Nov. 5, may I submit the following:

"Engineering: A practical, scientific knowledge in technical economic research."

"Geology: Scientific reading of mineral nature."

Zortman, Mont. JOHN FRANK.

Regeneration of Cyanide

THE EDITOR:

Sir—Mr. Kirsebom's paper on "Reducing Silver Sulphide Obtained by Cyanidation" contains a flow sheet for precipitation of copper from cyanide solutions. If the ore treated contains sulphides of copper, actual experiment shows that a large amount of the cyanide is changed into thiocyanide. As long as enough free KCN is present, the copper is kept in solution as $KCu(CN)_2$. When the solution is acidified the copper is precipitated as Cu CNS chiefly (80-100 per cent of precipitate is Cu CNS). Treatment of this precipitate in suspension with appropriate sulphides—such as H_2S or Na_2S, will liberate HCNS, which in turn slowly decomposes, or NaCNS. Mr. Kirsebom has not in any way shown how to overcome the destruction of cyanide—CN—which invariably goes to thiocyanide, with sulphide ores. His procedure will not regenerate any more cyanide than simple acidification and filtration, followed by the addition of a sufficient amount of lime to render the solution alkaline.

H. B. Wright *(Engineering and Mining Journal,* Vol. 115, p. 806) precipitated copper from cyanide solutions with sulphuric acid. He attempted to regenerate the cyanide in the precipitate with sodium sulphide in the primary acidification circuit as follows:

$$Cu_2(CN)_2 .2\,KCN + Na_2S + 2H_2SO_4 = Cu_2S + 4\,HCN + Na_2SO_4 + K_2SO_4$$

The reaction was incomplete. A 51.9 per cent regeneration of cyanide was obtained by neutralizing the liberated hydrogen cyanide with lime. Attempts to recover cyanide from the precipitate were unsuccessful.

Ottawa, Ont., Canada. A. C. HALFERDAHL.

Mr. Kirsebom comments as follows:

Copper sulphides are dissolved very slowly in a cyanide solution and will no doubt, as Mr. Halferdahl states, cause formation of thiocyanates, owing to the excessive aëration which takes place during cyanidation. Most silver-gold ores containing appreciable amounts of copper in this form have, however, to be given a previous treatment, such as roasting, as the presence of the copper in this form seems to have a retarding effect on the extraction of the precious metals. Ores in which small amounts of copper are present in oxidized form give good cyanidation, but formation of thiocyanates is not more marked in such ores than in ordinary ores. Thiocyanates will always form more or less in all mill solutions, and are generally lost as such in the slimes. They are in any case lost to the process, and it makes little difference in the cyanide economy whether they are precipitated out with the copper or not. It seems to me, therefore, that Mr. Halferdahl's first objection has more academic than practical interest.

As to his second statement, I am fully aware that a complete regeneration of the cyanide from the copper does not occur in the acidification of the mill solution. There is, however, every reason to believe, from results so far obtained, that the solution of this problem will be solved in the next stage of the process—namely, in the smelting. I am not yet in a position to discuss this matter intelligently, but hope to do so in a short time.

New York City. GUSTAF NEWTON KIRSEBOM.

NEWS OF THE WEEK

Summary

TWENTY MILES southwest of Bwana M'Kubwa, in Northern Rhodesia, the Roan Antelope Mines, Ltd., is developing an unusual disseminated copper deposit containing no other metallic mineral than chalcocite. Ore reserves at present are estimated at 20,000,000 tons, averaging 3½ per cent copper.

* * *

With the expiration next June of an arrangement between the Union of South Africa and the Province of Mozambique for the recruitment of East Coast natives, the mining industry on the Rand faces the probability of an acute shortage of native labor.

* * *

Returns of the Ontario Department of Mines indicate that for 1927 the metallic output of the province should show an increase of $2,000,000 over 1926; non-metallics, $1,000,000; and structural materials and clay products an increase of $3,600,000.

* * *

Hecla Mining Company takes over the Union mine and the adjoining Maple Leaf group, situated in the Franklin camp, near Grand Forks, in the Boundary district of British Columbia.

* * *

Last boat shipments of the year are made from the docks of the Michigan smelters. Combined cargoes for the month of November total 11,356,000 lb. of refined copper.

* * *

Sir Douglas Mawson, an Australian explorer, announces the discovery of a large deposit of potassium nitrate, 120 miles east of Alice Springs, Northern Australia.

* * *

Oreshoot recently discovered in the mine of the Benguet Consolidated Mining Company, in the Philippine Islands, is estimated to contain about $500,000 of high-grade ore.

Railroad to Flin Flon of Great Importance to Manitoba

Purchase of Property by H. P. Whitney Interests Considered Vital Factor in Large Scale Development of Mineral Resources of the Region

AS STATED in the preceding issue of *Engineering and Mining Journal*, the immediate construction of an 85-mile railroad line to the Flin Flon property from Sherman, 8 miles northeast of The Pas, on the Canadian National Railway, was provided for on Nov. 30, when the H. P. Whitney interests exercised their option to purchase the Flin Flon property in northern Manitoba and Saskatchewan. Unquestionably, this branch line will be an important factor in the development of the mineral resources of the entire region of northern Manitoba. This section is extremely favorable for prospecting, and, although discoveries of major importance have already been made in it, engineers and geologists are of the opinion that developments in the future will also be of great importance.

The present terminus of the line will be at the Flin Flon property, but in a short time it will have to be extended to the Sherritt Gordon property, which, excepting the Flin Flon, is the outstanding property in the region. Percy Hopkins, formerly of the staff of the Ontario Department of Mines, recently made a report on the Sherritt Gordon, and classes it as one of the most important discoveries made in the last few years. At the time of Mr. Hopkins' examination, three orebodies, totalling 5,570 ft. in length and averaging 14.7 ft. in width had been proven. In addition to this, there were two other sections totalling 3,000 ft. along the zone which had not been prospected, but which appeared to be ore bearing. Since the report was issued, a considerably greater length has been proven on the vein, so that any estimates would be substantially increased. Over 5,000 ft. of diamond drilling was done, which cut the vein at an average depth of 100 ft., showing widths of 11 to 17 ft. averaging 2.34 per cent copper, 5.9 per cent zinc and about 75c. in gold and silver. The deposit for the length mentioned by Mr. Hopkins will run 9,500 tons to the vertical foot in depth. He states that to the 200-ft. level, diamond drilling has indicated 1,900,000 tons of the above mentioned grade of ore from which he estimates a profit of $2.50 a ton. The deposit shows possibilities of containing 20,000,000 tons of ore of a gross value of about $14, which would be sufficient to support an independent smelter.

In addition to these two properties, there is the Mandy mine owned by the Tonopah Mining Company of Nevada. At this property, rich copper ores were discovered, and, during the war and the period of high copper prices, the ore was hauled a distance of over 40 miles by team, and shipped to the Consolidated Mining & Smelting plant at Trail.

The Flin Flon property was discovered in 1915 by Tom Creighton and Dan Mosher, who were prospecting for a syndicate consisting of Frank Curry, Alec Fasken and Jack Hammill. In the following years, the property was optioned several times, but the comparatively low-grade character of the ore and the distance from transportation prevented it being brought to a producing stage. It was first optioned to the Fasken-Black syndicate, which spent a large amount of money in diamond drilling and proved up the greater part of the known tonnage. When this option was dropped, the Hayden Stone people became interested and spent further sums. Subsequently, Col. W. B. Thompson and associates took an option and this was followed by the Mining Corporation, which has controlled the property for a number of years. The present holdings of the Whitney interests comprise 153 claims and fractions, embracing about 5,700 acres. Of the total claims and fractions, 116 were taken over from the Mining Corporation and 37 are those which the Whitney interests have staked or acquired. Scott Turner, now Director of the U. S. Bureau of Mines, was consulting engineer for the Mining Corporation and he succeeded in interesting R. H. Channing, who represents Harry Payne Whitney. Prior to the time the Mining Corporation obtained control, Jack Hammill was practically alone in his consistent and enthusiastic support of the property, but it is to Scott Turner that the major part of the credit must go for negotiating a deal which will have so important an effect on the development of northern Manitoba.

Expansion of Operations Prevails at Many Montana Properties

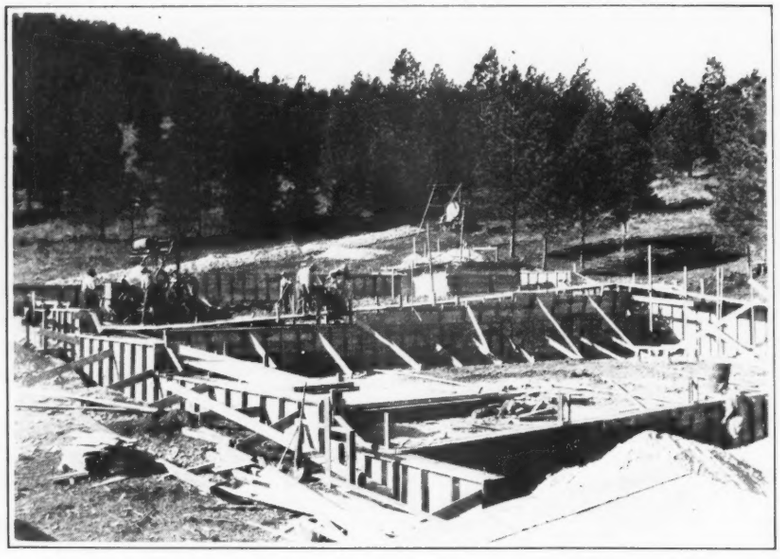
Montana-Idaho Mines Corporation Completing Cyanide Mill at Spring Hill Mine—Domestic Manganese & Development Company May Operate New Plant Jan. 15

GOOD progress is being made by the contractor in building the 150-ton cyanide plant at the Spring Hill mine of the Montana-Idaho Mines Corporation near Helena, Mont. It is planned to have the plant in operation, under the superintendency of C. L. Hewitt, before the first of the year. At the company's East Pacific property, near Winston, the stope on the No. 7 level has opened up to 30 in. of high-grade galena ore, and two more cars were recently shipped. The Kleinschmidt mill is now in operation and contractors are hauling concentrate to the railroad. The company, at the East Pacific, is also raising on the No. 7 level to the No. 6, and has a large force of outside men preparing for winter operations. At the January property a vein has been encountered exposing 18 in. of high-grade milling ore. The orebody at the Kleinschmidt will be tapped 200 ft. lower by driving a tunnel on the Irish Syndicate property.

Four carloads of equipment have been received at the plant of the Domestic Manganese & Development Company, Butte, and ten additional cars will soon arrive to complete the first unit of the $400,000 plant of the company for the nodulizing of manganese ores of Butte. The machinery will be installed under the supervision of John H. Cole, president of the company, and R. F. Feind, engineer of the Allis-Chalmers Manufacturing Company. Pink manganese ore will be received from railroad cars and transported to a trestle 45-ft. high. Cars will be dumped into two bins, each having a capacity of 500 tons. From these bins the ore will be conveyed by belt and elevator to bins which feed the rotary kilns; in these kilns, the ore will be dried and nodulized. After the roasting, the product will be transported to rotary coolers and thence to shipping bins. Powdered coal will be used for fuel, combined with heated air drawn from the coolers. According to information given out by Mr. Cole the plant of the property will turn out its first product about Jan. 15. It will have an initial capacity of 300 tons per day of ores assaying from 50 per cent to 57 per cent metallic manganese.

Butte Independent Mines Company, operating in the southwest part of Butte, on what is believed to be an extension of the veins of the Ardsley Butte Mines Corporation, is making good progress in sinking its shaft to the 250-ft. point. From that point, crosscuts will be run to open two veins showing on the surface, where the veins were about 4 ft. wide and showed commercial mineralization. Trenching on the surface has exposed four additional veins on the company's 400 acres, but it is not planned to prospect these veins until the shaft has reached a greater depth.

Anaconda Copper Mining Company has resumed operations at its Mountain Con mine, Butte, with a crew of 500 men. The mine suspended operations about a year ago to permit of repairs being made to the shaft and to install a 5,000-ft. electric hoist. During the shutdown a change house with 800 lockers and 100 shower baths was installed and a new type of steel ore bin of 3,000 tons' capacity was also completed.



Mill construction at the Spring Hill mine, near Helena, Mont.

Two High-Graders Convicted at Cochrane, Ontario

At the trials of eight high-graders, at Cochrane, Ont., only two were convicted. The grand jury returned true bills in the case of six men; of these four were tried, the Crown prosecutor deciding to withdraw two cases. The total amount of gold involved amounted to approximately $6,000. Of the two men sentenced, one received four months and the other eighteen months. So much attention has been drawn to high-grading in northern Ontario gold camps that the government sent a special prosecutor to Cochrane for these cases. In the past, great difficulty has been experienced in getting sentences commensurate with the offence, and cases have been treated with great leniency by both judges and juries. The government has decided to co-operate with the mining industry in an effort to suppress illicit traffic in gold, and has assigned a special prosecutor for this work.

Conviction of Charles Peter Reversed by Circuit Court

The U. S. Circuit Court of Appeals, on Dec. 5, at St. Louis, reversed the conviction of Charles Peter, of Salt Lake City, a mining promoter and operator, who on Mar. 28, 1925, was sentenced to eighteen months in prison following his conviction by a jury on the charge of using the mails to defraud. The appellate court held that the indictment failed to charge in legal form the offense as outlined by the trial judge in instructions to the jury.

In the opinion reversing conviction, the court of appeals quoted Judge Tillman D. Johnson of the U. S. District Court as saying in his instructions to the jury that Peter was the organizer of a number of successive corporations called the Mascot group; that he induced purchase of stock in these corporations by false representations, and that by loaning money to a corporation, and later by legal devices bringing about the sale of assets, he came into control of assets, and then organized a new company and started the scheme again.

The appellate court held the indictment failed to charge this state of affairs, and if this was what the defendant was charged with he should have been put on his notice so that he could prepare a defense.

High-Grade Ore at Benguet

The recent discovery of high-grade ore in the mine of the Benguet Consolidated Mining Company, in the Philippine Islands, is said to have been made on Level E west and represents an oreshoot making out from a stringer in the hanging wall which has been followed for about 50 ft. and shows a width of 5 or 6 ft. It is estimated that the rich shoot contains about $500,000 of high-grade ore.

Staff of Roan Antelope Copper Mines, Ltd.

First row, left to right: King, master mechanic; Calder, assistant manager; F. P. Williams, manager; Teasdale, accountant; Froude, compound manager. Second row: Sims, medical orderly; Andrews, geologist; Jeffreys and Moore, surveyors; Crouchley, forest section; MacLachlan, draftsman; Pellew, assayer, and Williams, assistant surveyor.

Roan Antelope Mines Developing an Unusual Copper Deposit

Disseminated Ore on Property in Northern Rhodesia Contains No Other Metallic Mineral Than Chalcocite—Lode Mineralization Extremely Uniform

By George L. Walker
Special London Correspondent

A LARGE deposit of disseminated copper ore which contains no other metallic mineral than chalcocite is difficult to comprehend. Yet such a deposit is being developed in Northern Rhodesia, Africa, by the Roan Antelope Mines, Ltd., of which A. Chester Beatty is chairman of the board. Although small amounts of bornite and chalcopyrite have been encountered, the lode apparently contains no pyrite, pyrrhotite, zinc, arsenic, antimony, or precious metals.

The interesting possibility is suggested that in smelting the concentrate from this ore it will only be necessary to melt it down to white metal and then blow this, while still molten, into blister copper, as there will be nothing to eliminate but sulphur and such bits of rock material as may be picked up with the chalcocite.

Other interesting things about this property include an astonishing uniformity of mineralization and the rapidity with which it is being developed. During the past sixteen months—work not having been started until early in June, 1926—about 9,000 ft. of shafts, drifts, and crosscuts have been driven, and about 6,000 ft. of drilling has been done. In every opening—wherever the lode has been broken into, drifted on, or crosscut — commercial ore has been found to occur continuously. The extreme variation in several drill holes spaced 1,000 ft. apart was 1 per cent of copper.

Five shafts have been sunk, two of which are down 630 ft. and the other three to the 430 level. From these, about 5,000 ft. of drifting and 1,400 ft. of crosscutting have so far been completed. Mr. Beatty said at the company's first meeting, which was held recently:

"The ore to a depth of 100 ft. is all oxidized, but below that depth sulphide ore is encountered, so that except for a comparatively small tonnage near the surface the orebody consists of sulphides. Our engineers estimate that of ore of this character we have already developed 20,000,000 tons, averaging 3½ per cent copper. In addition to this quantity, there is a substantial tonnage of ore partly developed, and there are good reasons for expecting further satisfactory results in the part of the basin as yet unexplored.

"In the proving of the 20,000,000 tons, . . . less than one-fifth of the probable extent of the orebearing shale formation has been developed, and, in the view of our engineers, the total quantity of ore in the basin is not likely to fall short of 50,000,000 tons, and it may prove to be considerably more."

T. F. Field, an American mining engineer, who is a director of the company, and A. G. McGregor, the designer of copper-concentrating and smelting plants, were at the property together recently. They recommend a plant to treat 1,500,000 tons of ore yearly. Mr. McGregor expects the flotation recovery to be about 95 per cent, the concentrate running about 55 per cent, and estimates the smelting recovery from the concentrate at about 98 per cent. This probably would set up a new high record for percentage of total content recovered.

The plant recommended would give the company a productive capacity of over 90,000,000 lb. of copper annually. It is estimated that the cost of the copper would not be over £35 per ton, or, 7.6c. per lb. Mr. Beatty says the equipment of the property on such a scale will involve an expenditure of probably £2,500,000.

The ore deposit is a shale bed which occupies a synclinal basin and is about 30 ft. thick. A length of about 9,000 ft. has been demonstrated and a preliminary geological study indicates a probable length of 18,000 to 20,000 ft. It is apparent here, as at other ore deposits in the vicinity—the property is 20 miles southwest from Bwana M'Kubwa and about the same distance from N'Kana—that the mineralization is related in some way to a large intrusion of granite.

There were two groups of claims, the Roan Antelope and the Reitbok, together comprising 455 acres. After Mr. Beatty and associates took an option on these, they later purchased an adjoining additional 1,444 acres, making a total of 1,899, and they have developed the property, up to the present time, entirely with their own money.

The necessary railway has been surveyed and will be built soon. A pilot flotation plant is being installed at the mine. A. G. McGregor has been retained to design the permanent plant. W. Selkirk, who is associated with Mr. Beatty, laid out the plan for development when he visited the property last year, and since then has attended to the details of the work from London. It is intended that the speed with which operations have been carried forward so far shall be maintained until the stage of production is reached.

Iron Cap Copper Closes Copper Hill Property

Operations of the Iron Cap Copper Company at Copper Hill, Ariz., have been indefinitely suspended, owing to the exhaustion of the orebodies. Ore reserves had been dwindling for a number of years, and in 1925 the mine was shut down for some months on account of apex litigation with the Arizona Commercial Company, whose property adjoins that of the Iron Cap. At the same time $300,000 of the company's funds was tied up by an injunction in favor of the Arizona Commercial Company. In January, 1926, the federal Supreme Court affirmed a Supreme Court decision which gave the Iron Cap Company title the claims in dispute.

Hecla Company Takes Over Properties Near Grand Forks

Comprise Union Mine and Maple Leaf Groups—Washington Farmers Claim Trail Fumes Damage Crops

THE Hecla Mining Company, of Wallace, Idaho, has bonded the Union mine and the adjoining Maple Leaf group, situated in the Franklin camp, near Grand Forks, in the Boundary district of British Columbia, for $175,000, payable over a term of years. Between 1913 and 1920, inclusive, the Union Mining & Milling Company shipped 3,612 tons of ore, averaging $33.68 per ton in gold, silver, and copper, to the old Granby smelter, at Grand Forks, but when the smelter was closed the mine also was closed, and only a little work has been done on the property since. This ore was taken from a width of about 20 ft. in a wide pyroxenite belt, which crosses the Franklin camp. Chalcopyrite together with pyrite occurs in stringers and pockets throughout the belt, the concentration of the minerals, being much greater in some places than in others, however. The chalcopyrite on the Maple Leaf property has been demonstrated to carry varying amounts of platinum, but as yet the smelters in British Columbia have not the facilities for recovering this metal. In the search for platinum by the Munitions Resources Commission, during the last years of, and immediately after, the war, this belt received considerable attention. The richest sample, one taken by J. J. O'Neill, then of the Canadian Geological Survey, but now of McGill University, assayed in the laboratory of the Federal Department of Mines, at Ottawa, showed 0.38 oz. of platinum per ton. This sample was a piece of fairly clean chalcopyrite, taken from near the junction of the pyroxenite on the hanging-wall side of the lode. The Hecla company has moved a prospecting plant from Wallace to the Union mine, and has started two tunnels across the lode. Current operations are under the supervision of Paul H. Schultz, in whose name development will be conducted until the Hecla company has taken out the necessary license. An assay office is being erected, and an assayer will be kept at the property during exploration.

J. Strombeck and A. Pearson have bonded the North Star group, situated near the Dolly Varden mine, in the Alice Arm district, for $50,000, payable over three years, and have started an adit 100 ft. below the old bottom adit. It is contended that the North Star is likely to contain the extension of the Dolly Varden orebody, from which more than 1,000,000 oz. of silver was taken in 1920-21. The Dolly Varden deposit was so broken by faults that it was difficult to follow.

Since the erection of its two 409-ft. reinforced-concrete stacks at Trail, the Consolidated Mining & Smelting Company of Canada has been receiving claims from farmers in the State of Washington for damage to their crops by smelter gases. The farmers contend that the high stacks are the cause of gases being carried to their farms. For the purpose of rebuttal evidence the Consolidated company has had a series of photographs taken from an airplane. The photographs will cover an area of about 140 square miles around the smelter.

Potash Deposit Found in Northern Australia

THE announcement has just been made by Sir Douglas Mawson, an Australian explorer, of the discovery of a large deposit of potassium nitrate 120 miles east of Alice Springs, Northern Australia. Sir Douglas says that geologists have always expected to discover deposits of nitrate and of potash salts in the arid territories of Australia, but not in the combination now found.

Larger Operations by Bonanza Placers in 1928

Large-scale operations are planned for the 1928 season at the Leesburg (Idaho) placer mines of the Bonanza Placers, Inc. Throughout the winter, a small crew will be employed to cut lumber and enlarge ditching facilities. Forty men will be employed at the Moose Creek and California Bar camps of the company.

During the summer three automatic reservoirs, one large storage reservoir, and two pipe lines were built in Swamp Gulch in addition to considerable preliminary work in Rapps Creek. Next year, the company, according to its president, C. A. Poulson, will operate two giants in Swamp Gulch and two in Rapps Creek, 24 hours a day. Salmon will continue to be the principal trading point and freight will be hauled in over the Leesburg hill.

Fairbanks Company Begins Assembly of Dredges

Syndicate Organized to Send Out Prospectors and Supplies by Airplane Next Spring

THE Fairbanks Exploration Company had 900 men on its payroll last summer, and will soon begin the assemblage of its first two dredges so as to have them in operation next summer. With the two new dredges installed during the last season on Fish and American creeks and with those working on Chatham, Fairbanks, and Nome creeks, the Fairbanks district promises to be the leading gold-producing section of Alaska for some time. Dredging development here is attracting the attention of other investors. Engineers representing the Lewisohn interests of New York and two English companies were actively engaged in a survey of the field last summer. A Fairbanks syndicate has been organized to send prospectors and supplies by airplane to prospect the Noatak, John, and Kobuk rivers next spring.

At Valdez, the Devinney-Dolan mine, on Mineral Creek, is being developed, and the construction of a mill is under consideration. Ore of a good value has been proved for a depth of 150 ft. The Granite mine produced during the last season about 600 oz. of gold from 90 tons of ore. The plant is to be enlarged and hydro-electric power installed. Alaska Range Mining & Development Company, of Anchorage, claims to have uncovered a quartz vein, carrying gold for a distance of about 6,000 ft., on its holdings recently taken up on Valdez Creek. Fern Gold Mining Company of Spokane, operating on Willow Creek, plans to enlarge its mill to a capacity of 300 tons a day and to develope hydro-electric power for the purpose of operating the property throughout the year.

There has been quite a stampede to Good News Bay, south of the Kuskokwim, owing to a strike of platinum, said to have been yielding about 3 oz. per day per man.

Hydraulic monitor in action at Bonanza Placers

Last Boat Shipments of Year Leave Michigan Smelters

Load 11,356,000 lb. of Refined Copper During November—C. & H. Increases Forces at Several Mines

A TOTAL of 11,356,000 lb. of refined copper was shipped by boat from the smelters of the Michigan district in November, the last month of the season of navigation. It was the largest monthly amount of metal to be moved by water during the year. Most of the copper was consigned to the East. The bulk of the metal sold in the mid-West is used by Henry Ford and is moved in Ford's own boats. Calumet & Hecla Consolidated shipped 8,622,000 lb. by boat last month. From the Michigan smelter dock at Houghton, 2,642,000 lb. was moved, representing Copper Range, Mohawk, and Isle Royale metal. Quincy shipped only 92,000 lb., moving the bulk of its copper by rail. Metal will continue to be moved over the railroads throughout the winter.

Calumet & Hecla Consolidated continues to build up its underground forces in its several mines. Men are coming into the Michigan copper district daily from the automotive centers. This improvement in mining is reflected in better business conditions in Calumet and vicinity. The addition of more men, making for well-balanced forces, permits of a vigorous program of development work in conjunction with regular mining operations.

At the New Arcadian, sinking has been resumed from the 1,250 level of the New Baltic shaft. Lateral openings will be made as the shaft is deepened. As the shaft gets into more settled ground it is expected that better ore than that already revealed will be opened. Mineralization has been good, both in the New Baltic and New Arcadian veins, and, lying not far to the west of the New Arcadian lode, is another vein of considerable promise from which some rich rock already has been hoisted to surface. Though the new vein has not been definitely identified, it is believed to be the northern extension of the Arcadian or Isle Royale lode.

Steel is arriving for the erection of the fourth furnace unit at Calumet & Hecla Consolidated's smelter at Hubbell.

More Funds Sought for Bureau of Mines' Research

Senator Oddie, of Nevada, and Senator King, of Utah, Introduce Bills Increasing Appropriations Available to Reno, Berkeley, and Salt Lake City Stations

By Paul Wooton
Special Washington Correspondent

FAILURE of the budget to carry estimates for several phases of mining research which he has been seeking, has led Senator Oddie, of Nevada, to the conclusion that the best opportunity offered for securing more Federal recognition of the needs of the mining industry at this session of Congress will be to increase the amounts to be made available for each of the experiment stations.

There are in existence seven of the stations authorized by the Foster Act, but that legislation authorized the creation of ten such stations. Under that authorization Senator Oddie will introduce a measure fostering the Reno and Berkeley stations. At present each of the Foster stations receives $25,000 annually. Senator Oddie proposes to increase this amount to $50,000. In this way $275,000 additional money would be made available for research work on mining problems. It is known that the plan will receive strong support from Western Senators and Representatives.

Senator King, of Utah, has introduced a bill authorizing the appropriation of $500,000 for a major research station at Salt Lake City. It is his plan to establish in the West a large research station along the lines of the one maintained by the Bureau in the East at Pittsburgh. It is not his plan to supplant with this station any of the existing Foster stations. He believes Salt Lake City is the best site for such a station, as it is easy of access from the metal-mining stations and is a great center of the smelting industry.

Interstate Commerce Commission Hears Complaints

The complaint of the Superior Zinc Corporation, of Pennsylvania, against the Central Railroad Company of New Jersey, charging the railway and other lines with discriminating in favor of western zinc smelters, probably will not be acted upon until it can be investigated under the general rate structure examination embodied in the Hoch-Smith resolution. This was indicated by a recent communication from John J. Esch, chairman of the Interstate Commerce Commission, which stated that this complaint will be investigated under the Hoch-Smith resolution. He feels that the commission would regard it inadvisable to assign these rates for immediate hearings. More progress ought to be made on the parts of the case already begun before assigning new parts, he thinks.

The communication further stated however, that if the complainant, and other zinc smelting companies, which have been permitted to intervene, would bring to the attention of the chairman of the commission the essential facts of the case, and indicate why the hearings should be given immediate consideration, the chairman would bring the matter to the attention of the commission. The other zinc-smelting companies permitted to intervene are the United Zinc Smelting Company, operating a plant at Moundsville, W. Va., and the Federated Metals Corporation, with a plant at Trenton, N. J.

In a statement made by the United Zinc Smelting Company, the attention of the commission is directed to the fact that the rate on its product to New York City is $3.80 per net ton; whereas smelters in the states west of the Mississippi are accorded a rate of $12.50 per net ton all the way from Anaconda to New York. This statement also charged that the Western rate on metals had been reduced on several occasions without readjusting the local Eastern rates.

Nitrate Shares Favored in England

There is an unusual active demand for the shares of British nitrate companies owing to the rise in the price of nitrate, according to the *Wall Street Journal*. Big profits are anticipated because costs of production of British companies vary between 13s. 6d. and 15s. 6d. per metric quintal, and price of nitrate has risen to 18s. per metric quintal.

Ten British companies now have oficinas in operation or plan to open them in the near future. Two companies, Angela and Pan de Azucar, are believed to have earned 30 per cent on the current season. Both are cheap producers and are in a strong financial position. The majority of other companies have rather large bank debts, and dividends for the current year will probably vary between 5 and 10 per cent. The table below shows the financial position of ten leading British nitrate companies at the end of 1926.

Although most of the British companies sold the bulk of their output for the current season at 17s. per metric quintal, their profits for the year ending June 30, 1928, are likely to be considerably higher than for some years. Present demand for Chilean nitrate is exceedingly good, but prospects after the end of the current season are uncertain.

	Capital	Reserves	Bank Debts	Accounts Payable
Pan de Azucar	£110,000	£82,268	.....	.....
Lautaro	6,559,440	440,514	.....	£216,984
New Paccha	68,700	11,216	.....	.....
Alianza	500,000	376,991	£411,676	112,154
Liverpool	350,000	269,180	195,965	223,761
Rosario	600,000	39,924	186,000	42,370
Tarapaca	400,000	149,210	.....	122,230
Angela	70,000	44,988	.....	.....
New Tamarugal	546,000	362,726	65,486	194,067
Salar del Carmen	220,000	63,874	.....	36,960

Toronto Letter

By Our Special Correspondent for Northern Ontario

Ontario Production Figures Reveal Increased Output for the Current Year

TORONTO, DEC. 3—The returns of the Ontario Department of Mines for the output of metalliferous mines, smelters, and refining works for the nine months ended Sept. 30, show a total value of $49,919,113, an increase of $1,500,000 compared with the record for the corresponding period of the previous year. The output of the chief products, with their value, follows:

	Quantity	Value
Gold, oz	1,165,044	$24,081,275
Silver, oz	7,094,420	4,009,747
Platinum metals, oz	11,578	761,714
Metallic copper, and copper in matte exported, tons	17,174	3,897,310
Matte, nickel, and nickel in matte exported, tons	22,765	9,874,982
Nickel oxide, lb	6,945,211	1,661,039
Metallic cobalt, and metal contents of oxides, salts and unseparated oxides, lb	617,940	1,246,158
Pig lead, lb	5,581,435	384,816

The general trend of conditions in the gold, silver, nickel, and copper industries has been buoyant, and developments in the mining of these metals indicate an increased production during 1928. For the full year 1927, the metallic output should show an increase of over $2,000,000; non-metallics, $1,000,000, and structural materials and clay products an increase of $3,600,000, or a total increase of the mineral output of Ontario of $6,600,000.

THE output of gold for the nine months shows an increase of over $900,000, but the rate of increase for the last quarter should be substantially greater. The output of silver in ounces was in excess of 1926, but on account of the lower prices the total value is less. Owing to the greater activity of the Port Colborne Refinery of the International Nickel Company, the value of the nickel and copper output was greater, although the exports of matte were also greater.

During the nine months, the mines of the Porcupine district milled 2,610,413 tons of ore, having a gold value of $17,288,659, or an average value of $6.60 per ton. The Kirkland mines treated 557,185 tons and recovered $6,743,214, an average of $12.10 per ton. The output of the Kirkland camp for the nine months was greater than for the full twelve months of 1926. In the Sudbury district 974,311 tons of ore was smelted and 61,987 tons of matte produced. Of this amount, 25,723 tons was exported.

Developments at the Central Manitoba Mines, in eastern Manitoba, have been very encouraging, and on what is known as the "Tene" shaft several veins carrying high-grade ore have been located in recent crosscutting and drifting operations. To develop this section an electrically driven compressor and hoist have been ordered. The shaft is distant about three-fourths of a mile from the main workings. The company has recently let a contract for its winter freighting and another for widening the power line right-of-way. Considerable difficulty was experienced soon after milling was started by power interruptions from trees falling on the power line. The right-of-way will now be cut on a minimum width of 100 ft., which should relieve this situation. In the same district the San Antonio Mines has ordered new boilers and machinery, and has let a contract for the cutting of 1,500 cords of wood. Power troubles have also delayed progress at this property. The crosscut at the 300 level has not yet cut the vein.

To take care of the prospective increased demand for power in the Kirkland Lake district, a new substation is being built on the Teck-Hughes property. This substation will have a capacity of 6,000 hp., which will be additional to the 7,500 hp. of the substation on the Lake Shore property. In the main substation, the 25 cycle to 60 cycle frequency changer has been installed; this has a capacity of 5,000 hp.

Tonopah Canadian Mines has suspended all work at the Walsh property in Gowganda, and will confine its work in that district to development of the Morrison property. Stoping operations at the Walsh did not give as good results as were indicated by the drifts, and, with silver between 50c. and 60c., little or no profit could be made.

At the Potterdoal property, in the Matheson district of Ontario, it has been decided to continue the shaft to the 300 level. The shaft is now 70 ft. deep on a vein carrying copper and zinc. The ore in the shaft has been better than anticipated, and the company has decided on a more extensive campaign of development.

Results on the 2,600 level of the Kirkland Lake Gold Mines are satisfactory and show 15 ft. of ore of good grade. The company has decided to resume sinking immediately, and a new level at 2,725 ft. will be established sometime in January. It is probable that sinking will be carried on practically continuously.

Some remarkably rich gold ore is being mined at the M. J. O'Brien property in Cadillac Township. Development to date indicates a comparatively small body of high-grade ore, estimates of its value running as high as $1,000,000.

In the Michipicoten district the Pioneer has let a contract for a shaft on the Jubilee vein. This will be an incline shaft and will be sunk to a depth of 500 ft. Diamond drilling above the 250 level indicated a substantial body of ore.

Wright-Hargreaves has also cut its north vein on the 1,625 level, where it shows rich ore over a width of 6 ft. A new hoist will be installed on the 1,500 level of the south shaft to facilitate sinking without interfering with hoisting operations.

London Letter

BY W. A. DOMAN
Special Correspondent

Possible Shortage of Rand Native Labor Affects Kaffir Shares

LONDON, NOV. 29—Holders of Kaffir shares are having a rather uncomfortable time. Cablegrams from Johannesburg are painting the native labor position in rather gloomy colors. An arrangement with the government of the province of Mozambique for the recruitment of East Coast natives comes to an end in June next year, and already the shortage is being felt in the mines. Without an adequate supply of natives, the mines cannot be worked profitably, and correspondents from Johannesburg have been sending communications to journals on this side with reference to the growth of native labor unions. The Kaffir "houses" profess to see nothing disturbing in this, though apparently other people are beginning to argue that the native, as he feels his strength and solidarity increasing, may demand in higher wages a bigger proportion of the wealth that he produces. The position, apparently, is one that has to be taken into consideration. There is talk of reduced dividends being declared next month as the result of the current shortage of native labor, and already shares are being offered on the market, following a lead from the Cape, where people are supposed to sense the position in advance.

THE tin position has become interesting again. The London Tin Syndicate is largely increasing its capital in order to buy shares in a Malayan company called The Alluvial Tin, Malaya. This latter company holds shares in a number of tin properties that are little known on this side, but are said to be well known in Sydney. In that center it would seem that people have over-speculated, and that the present sale may help them out of their difficulties. Many of the companies are working, but so far none has paid a dividend. Others again are said to have "hope" as their main asset, seeing that the overburden of swamp is deep, and that Chinese methods of recovery are entirely unsuitable for the properties.

The Burma Corporation's report for the twelve months ended June 30 last, issued on Saturday, is a remarkable document, and shows what a wonderful deposit is being worked. Mill operations have been considerably improved and the fire area in the mine has been gradually reclaimed. Refined lead produced was 56,791 tons, and silver 5,088,042 oz. Extraction from the mine was 411,886 tons, and the ore reserves are estimated at 4,114,610 tons assaying 22.4 oz. silver, 26.2 per cent lead, and 16.6 per cent zinc.

Mexico City Letter

By W. L. Vail
Special Correspondent

Principal Northern Lead Producers Reduce Operations

Mexico City, Nov. 30—The principal lead producers in the northern part of Mexico are reducing their operations on account of the low price of metals. They have made a united request upon the Treasury Department for a reduction in certain taxes and also upon the management of the National Railways for a reduction in freight tariffs. It is understood that they expect friendly consideration in both cases. Otherwise, some of them will be forced to suspend operations until better prices can be obtained. Some of the copper properties are also continuing the policy of reducing their working forces. In the Cananea Camp, Sonora, 511 more men were recently discharged. The Moctezuma camp, in the same state, however, is operating with unreduced personnel.

On Nov. 12 the management of the Cia. Minera de Piedra Bola advised the Department of Commerce, Industry and Labor of a suspension of exploitation work at that mine until new orebodies could be opened. Piedra Bola has been losing money for several months. The Mazeta and Amparo mines, belonging to the same company, continue to operate. Negotiations continue toward a permanent adjustment of the labor difficulties in this district, and there has been no recent friction. Armed bands of discontents effect operations in a number of smaller camps in the State of Jalisco, particularly in the vicinity of the Bolanos section, but the government is now placing heavy forces in the state in an effort to maintain order.

THE Northern Mining Company, of Zacatecas, which has a contract for working a portion of the Vetagrande properties, has temporarily suspended work on these tracts, but will carry on exploration work in the adjacent mineralized zones. The Pittsburgh Vetagrande Mining Company, which also has a contract on a section of the Vetagrande claims is continuing to operate, the ores being treated at the San Francisco cyanide plant. It is stated that the Pittsburgh Vetagrande will also dewater a portion of the old workings and exploit them.

The Suriana mine, in the State of Guerrero, which is being put in condition for exploitation by the Peñoles company, is reported to have blocked out sufficient ore to run the 300-ton smelter for the next five years. The Suriana is in the midst of a rich mineral zone, but prohibitive for small companies or prospectors because of the high costs of transportation, to and from the property. If the proposed automobile road down the Balsas valley materializes, activity should increase in that region. It is also stated that the Peñoles management is highly pleased with ore-development operations at the Achotal property, and that the new mill on the property will probably be operating by the first of next year.

A project is before Congress to reform—reform is the word used—an article in the mining law which obliges municipal authorities who handle funds turned over by mining companies for the benefit of workmen, to exhibit a bond for the faithful performance of their obligations. It is alleged that in many cases the sums handled are insignificant and that the bond requirement is unnecessary, distasteful, and frequently the cause of delay in getting these funds into the hands of the municipal authorities.

The last annual report of the Mexico Mines of El Oro, which was recently issued, is rather disheartening. It shows a profit for the fiscal year of £3,229; exploration work during the year developed no new deposits of importance, although a limited amount of good ore was encountered on the 5 and 7 levels. At the close of the year the reserve ores were estimated at 34,892 tons, against 112,660 tons on hand at the close of the previous year, as announced in the report for that fiscal year.

Cia. Minera y Beneficiadora de Inde claims to control the entire lime-porphyry gold-bearing belt of the Inde district, and is now remodeling one of the two 100-ton cyanide plants in the district with the intention of starting production at the earliest possible moment. The company is employing about 125 men and has given the district and its inhabitants the first touch of prosperity in several years.

Rails, and machinery consisting of boilers, pumps, air compressors, machine drills, and mine cars, are being assembled at Guamuchil, on the Southern Pacific Railway in Sinaloa, for shipment to the Copalitos mines. A 70-ton furnace for reducing mill concentrates to bullion is also included in the equipment. A shaft is now being sunk on the property to the 500 level; drifts will be driven on several levels, including the 200, 300, and 400.

Governor Abelardo Roderiguez, of Lower California, proposes to stimulate mining on the peninsula by means of freight airplanes. The governors of Durango and Zacatecas offer reduction in taxes where the amount invested is substantial.

United Verde to Market Its Own Copper

Commencing Jan. 1, 1928, the United Verde Copper Co. will sell copper produced at its mines in Jerome, Ariz., on its own account instead of through the United States S., R. & M. Company, which heretofore has handled sales in the domestic market. H. De Witt Smith, formerly general superintendent of mines, will be in charge of the sales office at 111 Broadway, New York City.

Johannesburg Letter

By John Watson
Special Correspondent

Union's Mineral Production in 1927 Shows Increase Over Last Year

Johannesburg, Nov. 1—The Union Department of Mines has just issued statistics which show that the total value of minerals for the first nine months, January to September, inclusive, of this year was £45,961,363, representing an increase of £2,932,181 compared with the record for the corresponding period of 1926. Gold accounts for £624,016 and diamonds for £2,167,762 of this increase. The following are the details:

	September, 1927	Nine Months, Jan. to Sept., 1927
Gold	£3,576,107	£32,187,362
Silver	9,958	88,628
Osmiridium	5,165	41,896
Platinum	10,164	118,389
Diamonds	1,054,376	9,615,390
Coal	336,139	2,881,709
Copper	25,138	410,071
Tin	26,020	258,064
Other minerals	39,131	359,853
Totals	£5,082,198	£45,961,363

AT THE recent meeting of the Native Recruiting Corporation, held in Johannesburg, the president of the Chamber of Mines said that the supply of native labor is still inadequate. Unless other sources than British South Africa can be made available, the expansion of the mining industry must suffer severely. He urged the government to remove the existing restrictions on labor from Mozambique.

Potgietersrust Platinum Company's technical committee reports that for the quarter ended Sept. 30 the pilot plant crushed and treated 5,600 tons of ore, from the Zwartfontein-Vaalkop orebody, producing 108.5 tons of concentrates in the flotation plant and 24.6 tons on the corduroy tables. Daily assays showed an average screen value of 5.87 dwt. and a residue of 1.76 dwt. platinoids; but the actual recovery gave 3.77 dwt. per ton, of which 1.59 dwt. was platinum and 2.18 dwt. palladium. The base metals contained in the concentrate were estimated at 6.2 tons of nickel and 3.1 tons of copper. On the corduroy, the platinum was more readily caught than the palladium. Nearly half the platinum recovered was caught on the corduroy and only 9 per cent of the palladium. The corduroy concentrate can be recleaned on James tables to 1/100 part of its bulk, containing 75 per cent of the precious metal. Experiments on Rustenbury sulphide ore, carried out with a small plant, proved that it responds more readily to both corduroy and flotation treatment.

The diamond market at Brakfontein is said to be good. A large stone of 44 carats found there recently was sold for £500. Another diamond of 33 carats was sorted out by an Indian, who received over £100 as his share.

Situation at the Mines

Sentiment Improves in Copper Mining Sections as Price of the Metal Advances—Production Decreases in Joplin-Miami District

By H. D. Keiser
Assistant Editor

WITH THE recent further advances in the price of copper and the increase in domestic and foreign buying of the metal, a more encouraging outlook is evident in the copper-producing districts. Stimulation of exploration and development work and slight increases in production are expected in several sections as a result of the improved condition of the market. In the Joplin-Miami district production has decreased markedly with the recession of the price of zinc concentrate. In the other non-ferrous metal-mining districts little or no change in the rate of production is noticeable.

Copper

Strengthening of the copper metal market will be particularly welcome in the Michigan copper district, where a constant battle against costs has been waged since the World War to enable the deep mines to compete with the copper producers of the West and Southwest. Not only will a better price for metal contribute to the earnings of the producing mines, but it will stimulate development and exploratory work, which have been at a low ebb for some years. Conditions generally are better in the district. An influx of labor has given the mines balanced forces, and efficiency is at its peak. Calumet & Hecla Consolidated, which has taken on many additional men in the last few months, is producing more than 9,000,000 lb. of refined copper per month, it is estimated. The company has begun an extensive exploratory program, and development work also has been increased. Mohawk is enjoying the lowest costs in its history, and production likewise is the largest, being at the rate of more than 20,000,000 lb. per year.

With further advances in the price of copper, accompanied by increased domestic and foreign buying, the recent rate of production at the leading Arizona properties was maintained during November. In some instances, as at the New Cornelia, which has put on a third, or "graveyard" shift for the first time in its history, the extent of operations has increased. Development of newly discovered orebodies at several of the larger properties continues.

Lead and Zinc

In the Joplin-Miami district the tendency during October toward an expansion of operations was followed in November by a sharp curtailment. With the recession in the price of zinc concentrate from $38 to $35—the lowest price of the year—weekly concentrate production declined from 17,000 tons to below 15,000, and unsold stocks in bins increased from 35,000 tons to 52,000. Although the month closed with zinc concentrate obtaining $37 and lead concentrate $85, instead of $80, as during the remainder of the month, practically no improvement in production was evident. For the first week of the month total concentrate production was 16,790 tons, net unsold stocks in bins amounted to 41,122 tons, and 137 mills were active. At the close of the month production dropped to 14,831 tons, unsold stocks increased to 52,631 tons, and the number of mills in operation declined to 131. Little, if any, increase in production is expected under present conditions of the concentrate market. Owing to the prevailing low prices, a large number of the lower-grade mines in the district have been shut down, and many of those which are operating are earning but small profits. Drill prospecting, development, and mill building have also been curtailed. The necessity for more economic production, however, has resulted in improved milling practice and the re-treatment of large tonnages of tailings containing recoverable zinc.

Lead and zinc production in the Coeur d'Alene district continued practically unchanged in November, despite low metal prices. Curtailment of output by the Hecla Mining Company, which has been practiced by the company during the last few months, is expected to reduce the district's annual lead production by about 10 per cent. Discontinuance of shipments early in the year by the Star, Highland-Surprise, Douglas, Tamarack, and Success properties will most probably result in the zinc production showing a decrease of 25 per cent or more.

Lead-Silver

As a result of better prices during November, there was a slight increase in production at the lead-silver properties in the Bingham, Park City, and Tintic districts of Utah. The month's record of shipments from the districts also showed a slight increase over October. Extensive exploration and development programs in progress at many of the properties were continued. As the end of the year approaches, the general outlook is that 1927 will be considered a year of comparative prosperity for the region, notwithstanding lower metal prices and undiminished operation costs. Exploration of the Cardiff overthrust contact at Alta, near Salt Lake City, has been stimulated by the discovery of a carbonate lead-silver orebody at the Cardiff mine.

In Arizona, Montana Mines Operations, a subsidiary of the Eagle-Picher Lead Company, is erecting a 200-ton flotation mill at the Montana mine, near Ruby. The plant is to be completed in March and will cost about $100,000.

Gold and Silver

November bullion production in the Tonopah district was valued at $130,000, which figure represents a decrease of slightly more than $10,000, compared with the valuation of the district's October output. The decrease is chiefly the result of the West End Consolidated Mining Company's closing its 265-ton mill, the oldest milling plant in the district. During the month, the main leases on the Brougher Divide ground, in the Divide district, were sold and consolidated. Shaft-sinking operations are being actively carried on by the World Exploration Company in the Hannipah section. Production from the Betty O'Neal property, in the Battle Mountain district, and from the Gold Circle Consolidated, in the Gold Circle district, remained unchanged at about $35,000 gross for each property.

Iron

November brought to a close the iron-ore shipping season on the Great Lakes, and practically no ore will leave the mines of the Lake Superior region until navigation opens next spring. The last month was a quiet one for the shippers, with only a trifle more than 2,000,000 tons moved. The total for the season was brought up to 51,107,136 tons. This was a decrease of about 12 per cent from the total of 58,516,876 tons for 1926. The mines have settled down to winter schedule, with the underground properties placing ore in stock on the surface. Few of the open-pit mines are conducting stripping operations this winter, most of them being well ahead with the removal of overburden.

The *E. & M. J.* correspondent on the Mesabi range prefaces his remarks on the local mining industry with the statement "It is damn cold outside—36 deg. below zero." After the shivers have left us, we continue with his report and note that, following the close of the ore season, the 350-ton shovel used on the Hibbing north property by the Oliver Mining Company was recently shut down for 30 days, but on Dec. 12 was again started at stripping operations, which are to be continued throughout the winter. The M. R. Hanna Company has moved the 350-ton electric shovel recently operated at the Wabigon mine at Buhle, Minn., to the Missabe Chief property, near Nashwauk.

Societies, Addresses, Reports

Status of the Mining Industries

By the Hon. HERBERT C. HOOVER,
Secretary of Commerce

IT IS ALWAYS a pleasure for me to join in the American Mining Congress, for not only has my own professional life been closely linked with the industry, but the Secretary of Commerce is specifically enjoined in the organic act creating the office to promote and foster the interest of the mining industry. And it is a vital part of our national life. It is one of those industries without which the nation could not go on for a week. It ranks second only to the agricultural industry in its contribution to our raw materials. Its production amounts to nearly 6½ billions annually, providing direct support to probably ten millions of our people through employment to about two million workers. But the industry has a greater importance than even these figures indicate, for with agriculture, forestry, and water power it furnishes the raw materials upon which the whole work of our civilization rests. When the raw materials of our mines emerge from manufacture with the added expenditure of labor and capital upon them, they have a wholesale value of over fifteen billions of dollars. And in this, the second stage of their application, they give employment to another two million workers and support to about ten million more of our people. A large portion of these manufactured commodities must filter through the retail trade; their total value when delivered to the consumer exceeds twenty billions of dollars. And from this distribution arises the support of many more millions of our people.

It is estimated that the products of agriculture when they reach the consumer, with transportation, manufacturing, and distribution costs added, have about the same value as the mineral industries—each of them thus contributing about one-quarter of our total national income.

No other continent has demonstrated its possession of such a magnitude of minerals as has ours, and such a bountiful distribution over our whole land. But our mineral resources differ in one essential from our other natural resources—they are not renewable. Agriculture, forests, and water power replenish their supplies from season to season. Some people conclude from the non-renewable character of the mineral supply that they must shortly be exhausted. The practical question is one of time, and time in these matters needs to be measured in generations, and apprehension of exhaustion needs to be tempered with many probabilities, including the advance in technical methods of extraction. In some of our minerals, such as coal, iron, and building materials, we can through a knowledge of their geological structure and occurrence make fairly good estimates of our reserves. We know that they will outlast many generations of Americans. In non-ferrous metals and oil, geology affords us no great basis for an estimate of future supply. We only know of the occurrence of minerals of this type by actual exposure of them, and we can thus make no estimates except upon reserves which have been proved by actual development by the process of mining. To develop them ahead merely for national satisfaction of assured future supply would imply an unbearable waste of capital. The consequence is that in these groups there is never a demonstrable assurance of more than a few years' supply ahead of us. Yet we have never failed from year to year to find new deposits and extension of old deposits. We might add, also, that not every acre of this land has been fully explored as yet. Not a year goes by without new discovery.

All of us who have been engaged in the mining industry realize the volume of ultimate supply is a factor of production costs and richness of deposits. Directly with cheaper extraction costs and higher prices for the minerals does the volume of available minerals increase. For instance, within our lifetime we can remember when 5 per cent copper ore was not in most localities considered to be of extraordinary richness, and yet improvement in extraction methods alone has made 2 per cent ore in most localities extremely valuable, and the volume of 2 per cent ore is many thousand times that of 5 per cent ore. I have no doubt that with moderate increase in the price of copper and with the improved extraction which we can look for at the hands of our chemists and metallurgists, the day will come when the content of a fraction of this will be considered within the estimates of future supply.

There is another phase of the question which bears upon the maintenance of our civilization even against exhaustion of some of our minerals, and that is the ability to substitute one for another in practical use. We can if need be substitute aluminum for copper, glass for tin, zinc for lead, coal and shale distillation in replacement of free oil, and a score of other substitutions. But despite these factors there is always some degree of national anxiety as to the future of these supplies, and from this anxiety flows the natural demand for conservation. I am one of those who believe strongly in all proper conservation and the utmost practical elimination of wasteful production and use.

The industry and the government have from time to time the responsibility to take stock of our mineral resources and to devise such measures of conservation as are practicable and possible. More particularly do practical measures lie within the realm of economical utilization and the elimination of waste in production. It is in these directions that the Department of Commerce is concerned. It is not concerned in interference in the conduct of the industry, but solely in promoting improved methods of extraction and use through economic and scientific research.

The mining industry, realizing its responsibility, itself initiated these services of the government, and through its insistence has emerged the Bureau of Mines and the special services given by the Bureau of Standards and the Bureau of Foreign and Domestic Commerce in the Department of Commerce and the Geological Survey in the Department of Interior. The industry has not asked much of the government in these directions, the total of our expenditures upon such services directly for the benefit of the industry being less than $4,000,000 per annum. I do not think anyone will complain of these demands upon our government, when we remember the vital character of the problems involved and the importance of the industry. The actual returns to the American people in saving of waste, cheapening of production and distribution, and the saving of life amount to many thousand per cent. Incidentally, the minerals industries in their raw materials stage alone pay direct taxes to the government amounting to over five times all the other raw-materials industries put together. I need not enlarge upon the service of these government agencies in research and otherwise. They are daily in contact with you throughout the country and the various officials of these bureaus will no doubt speak to you of the progress of their work.

The department is at all times interested in the companies' situation and progress in the mineral industries. Their stability is a large part of the stability of the whole country. If we examine the price levels of our important minerals we shall find that they are, compared with pre-war, below the average level of all commodities except perhaps in the case of anthracite coal and lead. The miner and the farmer have a joint complaint that the price levels of their commodities are both below the relative average price levels of the commodities they must buy and the wages they must pay. While the average prices of all commodities today are about 47 per cent above pre-war, copper is 21 per cent below pre-war, silver 8 per cent below; iron ore 14 per cent above; zinc 12 per cent above; aluminum 7 per cent above; and crude oil 18 per cent above.

Address at the American Mining Congress Convention, Washington, D. C., Dec. 1, 1927.

What Ails Lead—*If Anything*

Mining and Metallurgical Society Discusses Problem—J. R. Finlay Forecasts Price Above Rather Than Below 7c.

By A. B. Parsons
Associate Editor

WHEN J. R. Finlay, the principal speaker, painted a rather rosy picture for owners of good lead mines in the next ten years, at the monthly meeting of the Mining and Metallurgical Society of America, held in New York on Dec. 9, he did not escape without a considerable chorus of "Show me's" from a less optimistic group. At the same time, with one or two exceptions, none of those present was bold enough to oppose his forecast that the average price in the United States would be more likely to rule above than below 7c. per pound. Various factors having a bearing on the question are outlined in the accompanying tabulation. Anyone who can evaluate these with reasonable accuracy can make a good guess at the future course of the lead market; but in doing this a good clairvoyant should prove highly useful.

Mr. Finlay, introduced by Arthur Notman, chairman of the New York Section, first analyzed statistics for a good many decades to determine an average increment in production of slightly more than 3 per cent per year. This would be equivalent to 60,000 tons for each of the last three years. The facts, however, are that the increase in 1925 was 199,000 tons, in 1926 it was 97,000 and in 1927 will be about 73,000, or an average more than twice the approximate normal of 60,000 tons. To this "surplus" production Mr. Finlay ascribes the steady decline in price from 9.75c. two years ago, to 6.25c., the figure that prevailed for several months until a few weeks ago. Now, looking ahead ten years and assuming a proportionate increase, the requirements of the world for 1937 should be between 2,500,000 and 2,600,000 tons, or approximately 700,000 tons more than the production of 1927. Where is this quantity of lead to come from?

"Of the 370,000-ton increase since 1924," said the speaker, "253,000 tons is accounted for by North America: The United States 98,000; Mexico 90,000; and Canada 65,000. Together these three countries have produced in 1927 fully 60 per cent of the world's total. The only important prospective source of lead from an actually new mine in North America, so far as I am able to ascertain, is the Buchans River property now being opened by the American Smelting & Refining Company. Three important districts supply most of the lead of the United States. These are Missouri, Utah and Idaho, all excellent fields that have a long life ahead of them. But they produced less in 1927 than in 1926.

"The most important increase in recent years has come from the Picher field, which, though situated in Oklahoma, is part of the Missouri group. But Picher has reached its apex; it is not worked out, but it is marked out. In the Coeur d'Alene district, in Idaho, several famous mines lately have been worked out, including the Hercules, Tiger Poorman, and Standard. The Sullivan mine, in British Columbia, is not a new mine—its rise is accounted for by a new process for treating the ore. Australia's production comes almost entirely from the Broken Hill, discovered way back in 1883. Mount Isa, I believe, is a potential source of lead that may be regarded as new. The Bawdwin mine, in Burma, is not new. I have made inquiry in Europe from the French, Belgians, and Spaniards. Aside from a few small prospects they tell me of nothing new. The Peñarroya officials say frankly that the Spanish mines, once important producers, are playing out." Mr. Finlay estimates that possible production from new sources —that is brand new mines, and some of them rather "hazy"—as 84,000 tons per year. To make up the bulk of the remainder of the assumed 700,000 tons needed in ten years, mines will have to be found in remote and unexplored regions, according to his view.

Selective flotation, says Mr. Finlay, accounts for nearly all of the 370,000-ton increase in the last three years; but the process now is so generally used that no further important increment as the direct result of its introduction is to be expected. Two years ago, when lead was selling for 9.75c. per pound and was admiringly styled "the precious metal," the development that was to bring down the price — selective flotation — was really an accomplished fact. Today, argues Mr. Finlay, many who are inclined to be pessimistic fail to realize that the thing that will bring about an upward trend in the market already has happened—namely, that "selective flotation has shot its bolt." The price, says Mr. Finlay, was swept down by a gush of production, but not to a "low" price level, for 6.25c. cannot be called low. Now the output of selective flotation plants is part of what may be called the normal supply. The lead market, having weathered the powerful two-year onslaught of selective flotation—it is rather anomalous to speak of flotation as an unfortunate influence—is now back where it was in 1925, so far as the relation between supply and demand is concerned. Mr. Finlay concludes that some advance in price is to be expected in order to stimulate the necessary production.

L. Vogelstein, chairman of the board of the American Metal Company, shared Mr. Finlay's optimism, though his comment dealt with the more immediate situation. He pointed out that Germany will have increased in 1927 its apparent consumption of lead by 83,000 tons compared with the preceding year. Great Britain has increased its takings by 27,000 tons. This contrasts with a decline of about 7 or 8 per cent in the consumption in the United States. Though the outlook for industrial activity is good in the United States, the hope for the immediate future lies in Europe.

Mr. Vogelstein frankly referred to selective flotation as a "curse to the metal markets"—not only with respect to lead but to copper and zinc as well. "Two years ago," he said, "we thought that the high price would result in the

Factors Affecting Outlook for Lead

Favorable

1. Experience has shown an average increase in consumption of about 3¼ per cent a year.
2. Much room exists for expansion in consumption in foreign countries.
3. Decline rather than increase is to be expected from many of the present producing districts.
4. Reasonably assured production from districts that can be strictly classed as new, amounts to a comparatively small tonnage.
5. Selective flotation has "shot its bolt."
6. No great profit is being realized in some districts with lead at 6½c. in New York, or its equivalent of about £22¼ for foreign producers.

Unfavorable

1. The limit of mechanization of industry in the United States may be closely approached; if so the rate of increase in the per capita consumption may be expected to decline.
2. Higher prices will stimulate the use of substitutes.
3. Research may develop substitutes; as for instance, a fiber cover for electric cables, already said to have been perfected.
4. Secondary or salvaged supply is of rapidly growing importance.
5. Higher prices will automatically expand ore reserves.
6. Geophysical prospecting may reveal important deposits as yet unknown.

opening of new mines. That did not happen; but what might be termed new lead came from the selective flotation plants. Today, as Mr. Finlay has pointed out, the situation is different; and in contrast to the meeting of 1925, I look forward with confidence."

Another optimist was Louis D. Huntoon, but his optimism was for Canada as a producer of vast quantities of lead rather than for the market for the metal. He hoped that Mr. Finlay was right in his forecast of the price, but that he was disinclined to subscribe to his view was evident. He went so far as to predict that within ten years Canada will be producing more lead than the United States. As the figures for 1927 are about 150,000 and 690,000 tons respectively, it is evident that either Canada must advance with remarkable rapidity, or the United States must recede with similar rapidity, or both, if Mr. Huntoon is to prove a good prophet.

Aside from the American Smelting & Refining Company's operations in Newfoundland, he mentioned several prospects in Ontario; the Flin Flon, in Manitoba; and the Errington property, in the Sudbury area in Ontario, as specific sources of lead, and the rocks composing the "great pre-Cambrian shield" as less definite but quite promising sources.

At the Errington a 200-ton mill to handle ore won in development is being built, and within three years, according to Mr. Huntoon, a lead smelter, a zinc smelter, and a 10,000-ton concentrator should be in operation. A published article quoted by Mr. Huntoon mentioned $1,320,000,000 as being the "indicated" value that Fred W. Bradley had placed on the mine. This fantastic figure is quite a contrast to the modest authoritative estimate of 300,000 tons of ore with a gross metal content valued at $22 per ton. Mr. Huntoon makes his headquarters in Toronto; and it may be that he has in his blood the same virus that makes things in a mining way seem so big to everybody in Ontario. It developed later that there is only about 1 per cent of lead on the average in the Errington ore.

H. A. Guess, vice-president of the American Smelting & Refining Company, who directs the work of the company on the Buchans River, in Newfoundland, averred that, with the object, among others, of "laying the ghost of fabulous wealth," to be won from the exploitation of this property, he had made a statement recently for publication in *Engineering and Mining Journal*. A 600-ton plant for selective flotation is now nearing completion. From the treatment of ore containing about 7 per cent lead, 16 per cent zinc, and 2 per cent copper about 18,000 tons of lead per year will be produced at the start. The reserves so far calculated are about 3,000,000 tons.

Mr. Guess agreed that the worst was over so far as selective flotation was concerned, particularly in the United States. In Mexico the situation is a little different. He foresees further expansion because of the fact that operators for a time hesitated about spending the money necessary to build plants. In 1924 only 7,000 tons of lead was accounted for by selective flotation in Mexico. This increased each year to about 57,000 tons in 1927, and a further increase during the next few years to between 62,000 and 64,000 tons is estimated. At the same time there has been a falling off from other sources in Mexico. For instance, the total increase in 1927 has been only 34,000 tons, thereby indicating a decline of 23,000 tons from other sources. Mr. Guess hazarded no guess in figures as to the future price, but he appeared to be quite serene about it.

Sidney J. Jennings, vice-president of the United States Smelting, Refining & Mining Company, was hopeful but a little fearful. His particular reason for skepticism was his doubt as to whether the projection of the consumption curve into the future would continue its upward trend as Mr. Finlay had postulated. The matter of substitutes for lead loomed large in his mind, and he felt that the curve was likely to flatten considerably, or that it might even dip a little. A striking example of this change, he said, was that unfortunate mineral called coal. A few years ago a program of steady increase in consumption of coal was mapped out with extreme confidence; but instead of going up, it went down. He would love to agree with Mr. Finlay, but he was a bit pessimistic (perhaps congenitally so, he said), and he thought 7c. was probably high.

Mr. Finlay thereupon agreed that the curve of consumption might flatten somewhat and pointed out reasons other than substitution. One is the approach to saturation of this country with mechanical equipment; another is the growing importance of the supply of secondary or scrap metal. But he did not alter his prognostication as to the price level.

William G. Schneider, of the Copper and Brass Research Association, emphasized the growing ratio that the "secondary" supply bears to output of virgin metal. Another consideration that should not be overlooked is the development in the use of substitutes. He stated that a fiber cover for electric cables has been developed that meets the requirements as well as the lead armor that is in general use. As cable manufacture rivals the storage-battery industry as the largest single user of lead, the importance of this development should not be ignored. The consumption of lead for paint has not increased recently; and some decline in the quantity used for the making of storage batteries is not improbable. Another possibility, according to Mr. Schneider, is that building activity may decline; whereas about $600,000,000 annually has been the rate of expenditure for this purpose, $400,000,000 may be closer to "normal." Mr. Schneider's mind ran along a disagreeable track, but if he is correct there is no sense in shutting one's eyes to the facts.

Next came E. J. Cornish, president of the National Lead Company, generally considered to be the largest single consumer of lead and tin in the world. Mr. Cornish commented on the fact that he and Mr. Jennings, "the only round-bellied speakers," to borrow his phrase, were also the only pessimists. Just how Mr. Cornish qualified as a pessimist was not made exactly clear; although from the tenor of his remarks it seems likely that he was for the time being putting himself in the position of a producer of lead rather than in that of a consumer. In short, he did not seem to think that the price of lead was going to run away in the near future. "John D. Rockefeller," said Mr. Cornish, "is a devout man. In the early days of the oil industry people told him that it was a waste of money to build refineries. He remarked reverentially that he did not think that God would put so good a thing as oil into the ground without putting in enough to serve the purposes of mankind. So he persisted in his program, and his wisdom has been proved by the event. So, I think, it is with lead. It was a real pleasure to me to hear Mr. Jennings say that nature will take care of things. We may eventually have to pay a higher price, but I am sure that something will crop up to make the supply of lead adequate."

After Mr. Cornish's eloquence, the comments of the other speakers were rather anticlimactic. C. A. Merrill, of the Western Electric Company, remarked that an investigation into the "secondary" metal situation would prove very illuminating. C. V. Drew, vice-president of the Cerro de Pasco company, which is expected to begin producing lead on a large scale during 1928, did not add much to the discussion by making a tentative promise to say something at a similar meeting of the society to be held two years hence. John Allen admitted that the ores of the Mount Isa field, in Australia, were amenable to flotation, but would not commit himself as to the grade or extent of the deposits. R. M. Atwater, Jr., and R. D. Hoffman expressed views regarding Australia and Canada respectively, the substance of which was that the chances for finding big new lead deposits in those countries were sometimes overestimated.

What is the matter with lead? Nothing, or at worst not much!

Joplin-Miami Section Elects Officers

At the first 1927-28 meeting of the Joplin-Miami section of the A.I.M.E., held Dec. 5 at Miami, Okla., C. O. Anderson, of Baxter Springs, Kan., was elected president for the ensuing year to succeed P. B. Butler. J. W. Newton, of Miami, was elected vice-president; C. F. Williams, Miami, secretary, and E. Y. Ellis, Joplin, treasurer.

The board of directors elected for the year consists of P. W. George, W. F. Netzeband, J. W. Newton, E. Y. Ellis, I. L. Box, F. H. Gartung, C. F. Williams and C. O. Anderson.

Personal Notes

CHARLES BUTTERS is in New York City having recently arrived from San Francisco.

P. BOURIE, of San Francisco, long interested in hydraulic mining, left for his former home in France early in December.

R. C. GAMBLE has been given charge of work on the property of Realty and Mines of Rouyn City, Que., where exploration will be actively carried on.

CHARLES SPEARMAN has been engaged by the Capital Rouyn to make a detailed examination of that company's property in the Rouyn area of Quebec.

W. R. WADE has established himself at Lebanon, N. H., where he has acquired manufacturing interests in addition to his work as a consulting mining engineer.

JULIUS COHEN, mining engineer, has been given charge of operations at the property of the Copper Hill mines in the Clericy section of the Rouyn area of Quebec.

H. A. KEE, who sank the 4,125 ft. shaft on the McIntyre Porcupine, will superintend shaft-sinking operations on the Frood property of the Mond Nickel in the Sudbury area of northern Ontario.

FRANK CAMERON, assistant mine superintendent of the Braden Copper Company, Rancagua, Chile, has accepted a position with Patino Mines & Enterprises Consolidated, Inc., as mine superintendent.

JOHN WELLINGTON FINCH is delivering a series of lectures on Mining Geology at the Colorado School of Mines. During the second semester he will offer a course on "The Geology of Foreign Oil Fields."

WILLIAM H. HUBBARD, JR., general superintendent of the Nichols Copper refinery at Laurel Hill, Long Island, has been confined to the hospital with appendicitis recently, but is expected to resume his work soon.

ALEXANDER GILLIES has been engaged to take charge of operations on the Dunkin McBain property in the Patricia district of northern Ontario which has been acquired by the Jackson-Manion interests.

C. M. JACK, South African Mining Commissioner, who recently spent six weeks' leave at the coast, has returned to Lichtenburg. He took up his new post at Barkly West at the end of October.

PHILIP J. SHENON, who received his doctorate in geology at the Minnesota School of Mines in 1926 and his master's degree at the Idaho School of Mines in 1924, has been engaged by the Idaho Bureau of Mines and Geology to make a study of the ore deposits of the east side of Burch Creek from Nickolia southward in southeastern Idaho.

GEORGE H. GARREY, who returned to the East last week from a geological examination of the Piermont and Ruby Hill Apex mines, in the mountain ranges northeast of Ely, Nev., is now en route to conduct professional work in Arizona.

STANLEY M. WALKER, consulting engineer, will have charge of the engineering problems of the expedition organized by GEORGE M. WILLIAMSON to conduct explorations and to take deep sea motion pictures in the Pacific. Mr. Walker has been identified with mining since leaving the Colorado School of Mines in 1911. The expedition is expected to start within 60 days.

STANLEY M. WALKER

H. J. KELLEY general manager of the Dominion Iron & Steel Company of Sydney, N. S., has been placed in complete charge of operations, replacing J. E. MCLURG, vice-president, who remains in control of operations of the other subsidiary, the British Empire Steel Corporation.

HARRY E. TUFFT, mining engineer, became associated on Dec. 1, 1927, with the Grasselli Chemical Company, with headquarters at the main office, Cleveland, Ohio. Mr. Tufft was formerly connected with the U. S. Bureau of Mines, at Washington, and has made governmental surveys of the leading mining districts on the consumption, supply, costs, and life of mine timbers.

W. E. BARRON has accepted an engagement with North Charterland Company to do surveys. He has been connected with Rhodesian Broken Hill Development Co. since 1919, was in charge of mining operations when the Broken Hill skull was found, and has had charge of the Mulungushi hydroelectric survey from its inception to the completion of the large triangulation survey for the government.

Dr. BERT S. BUTLER, of the U. S. Geological Survey, and formerly geologist for the Calumet and Hecla Mining Co., has been appointed professor of geology at the University of Arizona, commencing with the second semester of the school term. Dr. Butler is at present engaged on a survey of the State of Colorado and will come to the university upon the completion of this work.

HARLOWE HARDINGE sailed from New York for Europe on the "Berengaria" on Dec. 14. Mr. Hardinge will be away on business for from four to six weeks. H. W. Hardinge and Mrs. Hardinge also sailed on the same date for an extended pleasure trip through Europe and the East. Mr. and Mrs. Hardinge and Mr. and Mrs. Richard Lloyd form a party of four on this trip, and expect to be gone about four months.

CHARLES HARDY has reorganized the old firm of Charles Hardy, Inc., which will continue under the same name with Mr. Hardy as president. Mr. Hardy has resigned the presidency of the Associated Metals & Minerals Corporation to devote his entire time to the business of Charles Hardy, Inc. H. K. MASTERS has been elected vice-president and director of Charles Hardy, Inc., and has retired from the Associated Metals & Minerals Corporation.

W. H. SCHACHT, general manager of the Copper Range company, Painesdale, Mich., and GEORGE R. JACKSON, of Ishpeming, Mich., general superintendent for the Cleveland-Cliffs Iron Co., have returned from Seattle, Wash., where they conferred with C. W. NICHOLSON, who is looking after development operations for the Washigan Mining Co. in Alaska. Michigan and Washington men are interested in the property, which is being tested with drills for placer gold. It is likely that mining operations will be started in 1928 with one large dredge.

CHARLES V. SALE, chairman of British Metal Corporation; W. MUIRE, a shareholder, and R. E. STAVERT and A. J. COULLS, Montreal and London representatives, respectively, for the corporation, recently inspected the site for the Ladysmith Tidewater Smelters' proposed ore reduction plant, at Ladysmith, Vancouver Island. They were accompanied by H. R. THOMPSON and HERBERT CARMICHAEL, the local promoters of the Ladysmith concern. Several mines along the British Columbia coast were visited by some of the party, with a view to gleaning a knowledge of the amount of ore that is likely to be available should the proposed plant be erected.

CHARLES W. GOODALE, who now resides in Boston and who for 35 years was in charge of properties comprising the present Anaconda Copper Mining Company, has spent three weeks in visiting Butte and other Montana points. Mr. Goodale always was prominent in the civic and club life of Butte and was honored at many dinners.

GERARD SWOPE, president of the General Electric Company, has established a loan fund of $25,000 to be awarded to employees or sons of employees of the General Electric Company and the International General Electric Company in the United States and to other students of Union College of not less than one year's residence at the college. Union College is at Schenectady, N. Y. Simultaneously with this announcement, President Swope today made known that the board of directors of the General Electric Company has also set aside $25,000 to be used as a loan fund for the education of employees or sons of employees of the General Electric Company, but with no restrictions on them as to the college they may wish to attend. Provision is made under both funds that the recipient shall, if in a position to do so, repay the amount loaned to him, with or without interest. Such money as may be repaid will be treated as a revolving fund and be again loaned under the same provisions.

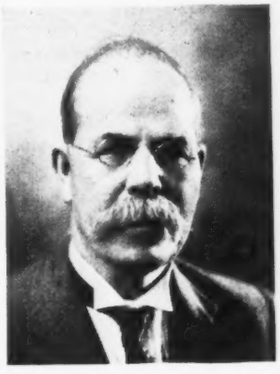
OBITUARY

JAMES F. VERNER, publicity manager of the A. E. Moysey Company, mining brokers of Toronto, Ont., died on Dec. 8.

BARTLETT LEE THANE, a mining engineer of San Francisco, died recently in New York City, at the age of 50. Mr. Thane was a graduate of the University of California. He went to Alaska in the gold-rush days. While there he was associated with D. C. Jackling in the Alaska Gastineau Mining Company, of which he was manager. For the last ten years he had maintained an office in San Francisco. He was a member of the A.I.M.E. and many clubs and fraternal organizations. Mr. Thane leaves a wife and daughter.

RALPH NICHOLS died recently at Aurora, Ill. He was born at Nyack, N. Y., Feb. 2, 1855, and graduated as C.E. and M.E. at Columbia in the class of 1879. In 1882 he took charge of the Viola mine, at Nicholia, Idaho; the town was named after Mr. Nichols. In 1886 he went to Nevada, where he was manager of the famous Sutro tunnel property of the Comstock Tunnel Company. From there he went to Hailey, Idaho, where he had charge of the Jay Gould Mining Company. In 1893 he went to Delamar, Nev., as superintendent of Delamar's Nevada Gold Mining Company, where he installed what was about the first practical cyanide mill. In 1897 he went to Kalgoorlie, West Australia, and in 1906 he went to Durango, Mexico, as manager of the Avino mines of Mexico. He then returned to Gilmore, Idaho, to work his own property, "The Latest Out," a mine he located in the early eighties, of which he always spoke of as his "grub stake." This property turned out to be a good-paying lead-and-silver mine. Mr. Nichols had been a member of the A.I.M.E. since 1893.

P. G. MORGAN, recently completed fifteen years' service as director of the New Zealand Geological Survey. Mr. Morgan was born in Tasmania, Australia, in 1867, and when eight years of age went with his parents to New Zealand. His principal education was received at the high school, Dunedin, and at the Otago University. At the New Zealand University he obtained his M.A. degree, with honors in languages. He is also an associate in mining of the Otago University School of Mines, holds a certificate as land and mining surveyor from the same institution, and another as battery superintendent.



P. G. MORGAN

From 1890 to 1895 Mr. Morgan was engaged chiefly in coal mining and during 1895 and 1896 with quartz crushing and the cyanide treatment of ores. For eight years (1897 to 1905) he was director of the Waiki School of Mines. He then joined the New Zealand Geological Survey, with which he has been connected ever since, first as geologist and then as director, having been appointed to the latter post in 1911, as successor to Dr. Macintosh Bell. Part of 1916 and 1917 Mr. Morgan was also Undersecretary for Mines, but he was compelled, through overwork, to give up that position. He is a fellow of the New Zealand Institute; a member of the Council of the Institute of Mining and Metallurgy; for some years corresponding member of the Council of the South African Chemical, Metallurgical and Mining Society; fellow of the Seismological Society of America; and fellow of the London Geological Society. Mr. Morgan's publications include numerous articles and papers on mining, metallurgical, and geological subjects, issued in the "Proceedings" of various institutes, as well as in technical and other journals, including the *Engineering and Mining Journal* (1900-05), and the *Mining and Scientific Press*. He has likewise written quite a number of bulletins, embracing one of the "Minerals of New Zealand," issued by the New Zealand Geological Survey.

Eugene Allen Smith

A Sketch of His Life by Walter B. Jones, State Geologist of Alabama University, Alabama

THE death of Eugene Allen Smith, on Sept. 7 last, has taken from geology one of its most outstanding figures and the dean of American state geologists, and from Alabama perhaps its most universally loved and respected citizen. Born at Washington, Autauga County, on Oct. 27, 1841, and educated in the public schools of Prattville, a private school in Philadelphia, and the University of Alabama, he survived the Civil War and was able to go to Germany to complete his education. He received his Ph.D. degree from Heidelberg in 1869 *summa cum laude*, and went to the University of Mississippi as professor of geology. He assisted Hilgard in the Mississippi Geological Survey, in the fall of that year. He spent two years with Hilgard, who was a great inspiration to him, and then came to the University of Alabama (May, 1871) as professor of chemistry. On April 18, 1873, a bill was enacted into law reviving the geological and agricultural survey of the state and he was named in the law as State Geologist. In view of the fact that it was still during reconstruction days, with its reactionaries, he asked for an appropriation of only $500 annually, to keep some political office seeker from getting the appointment and thereby destroying the hope of developing the state's dormant natural resources. The work of the Survey was so splendid that the annual appropriation was increased in 1883 to $5,000. As the activities of the department increased, additional increases were awarded, and finally, in 1906, the State Geologist was given a small salary. Until that time he had served without salary, his employment by the University of Alabama having been regarded by him as sufficient compensation. His ability to keep the Survey intact for 54 years, and to leave it adequately supported, is a wonderful accomplishment and a challenge to anyone engaged or interested in this kind of work. During that span of years, he covered the entire state, largely by use of a covered wagon, and recorded the results of his studies in almost 5,000 printed pages, in addition to voluminous field notes and correspondence.

Every personal impulse or pleasure was made subservient to his teaching and the progress of the Survey investigations, his devotion to which won for him the absolute confidence of the people of his state. What the "Little Doctor" said about any mineral deposit was accepted as final even by the most rabid dreamer. Outliving his contemporaries, he had seen his state grow into one of great industrial importance which gave him great satisfaction in his declining years. In scarcely more than a week, after he was taken ill, he died with the full realization that he had done everything he could for his work and for Alabama.

Recent Technical Publications

A Monograph on Titanium

TITANIUM. With Special Reference to the Analysis of Titaniferous Substances. By William M. Thornton, Jr. The Chemical Catalog Company, New York. Price $5.

"Io son Titania" sings Filena in that showy soprano air from Thomas' opera "Mignon"; and it was of the same Titania, Queen of the Fairies, that Shakespeare wrote in "Midsummer Night's Dream." But this Titania apparently has nothing to do with titanium, which was named, according to the author of this book, after the "Titans," the fabled giants of anciant mythology, so we shall say no more about her.

Though the volume under review is devoted largely to the chemistry of titanium and its compounds, and is therefore not of special interest to the mining engineer interested in the production of the metal or its alloys, it nevertheless contains a few pages devoted to the occurrence of titanium in nature, and to the reduction of the ore to a material useful in industry. Rutile and ilmenite are, of course, the principal ores.

To one who knows comparatively little about steel manufacture, it is of interest to learn that ferrotitanium, when added to steel, does not make what is known as an alloy steel, but is merely a scavenging agent to remove impurities. It also interested the reviewer to learn that titanium tetrachloride is used to make the dense white airplane smoke for "sky writing"; and occasionally also for the production of smoke clouds used for the concealment of military operations, though for these purposes silicon or tin tetrachlorides are usually preferred.

An exhaustive treatise such as this should do much do extend the uses of this comparatively rare element. And yet, it is not so rare at that, for F. W. Clarke has computed that 0.58 per cent of known terrestrial matter is titanium, only eight other elements existing in greater abundance in the solid portion of the globe. E. H. ROBIE.

"NIGHT WORK IN INDUSTRY." National Industrial Conference Board, Inc., 247 Park Avenue, New York City. Paper, 6x9 in.; pp. 45; 75c.

The purpose of this study has been to present in a concise form the experience of a representative group of manufacturing establishments with night-work operations. Results of this study permit of a number of general conclusions. Night work in industry presents no peculiar difficulties if it is properly organized and if it means steady employment. The problem of night work would be simplified if all establishments were in a position to keep their night forces permanently employed on a rotating system of shifts. Establishments which assign their workers permanently to night work find it difficult to attract skilled and reliable employees, though there are exceptions in certain stable industries.

SOUTH AFRICAN GEOLOGY.—The Geological Survey of South Africa has issued a bulletin entitled "The Geology of the Country Around Vredefort," accompanied by a geological map. The possibility of the occurrence of ore of economic importance had attracted several geologists before the present research was undertaken. The main object of the work was to map in detail the entire Witwatersrand System, to compare it with the Witwatersrand and the Heidelberg, and to determine the true relation between it and the granites present. Price 10s., 6d., at the Government Printing Office at Pretoria.

MEXICAN MINING.—The report of mineral statistics for the year 1925 has been issued by the Department of Industry, Commerce and Labor, Mexico City. The contents of the 300 and more pages of this bulletin consist largely of tabular matter.

ZINC METALLURGY.—The latest bulletin of the Technical Series that is being produced by the University of Missouri, School of Mines and Metallurgy, at Rolla, deals with the properties of refractories in zinc metallurgy. Its authors are E. S. Wheeler, A. H. Kuechler, and H. M. Lawrence. The pamphlet, containing 139 pages in all, is divided into four parts. Part 1 deals with raw materials and body mixtures now in use; Part 2, with comparative value of various grogs and other materials; Part 3, with the comparative value of various clays; and Part 4, with the effect of reclaimed retort materials and zinc oxide upon the physical properties of retort mixtures.

PHILIPPINE RESOURCES.—The Government of the Philippine Islands has issued a bulletin entitled "The Mineral Resources of the Philippine Islands for the Years 1924-25." It is divided into three parts, as follows: Philippine Geology and Mining; Present Development of Mineral Resources; and Administration and Legislation. An interesting chapter of the bulletin is the one devoted to a description of the administration and disposal of mineral land in the Philippines.

GROUND SUPPORT—The *Mining and Industrial Magazine of Southern Africa*, in its issue of Oct. 19, has an article entitled "New Method of Underground Support at Government Areas." In it attention is directed chiefly to the method involving the use of concrete disks and pillars to hold up the back. At this property a plant has been erected for manufacturing the concrete "disks." The same issue contains an article discussing the use of pillars of this sort underground.

SHADOW MOUNTAINS—G. C. Riddell and E. D. Foster are the authors of an article entitled "Geology and Ores of the Shadow Mountains," which appears in the Nov. 15 issue of the *Arizona Mining Journal*. The district discussed is in San Bernardino County, Calif. The article covers five pages and is illustrated.

CLAY AND LIME—Two advance chapters of "Mineral Resources of the United States" have been received. They are, respectively "Lime in 1926," by A. T. Coons, and "Clay in 1926," by Jefferson Middleton.

REFRACTORIES—In an article entitled "Silica and Magnesite Brick in Metallurgical Furnaces," appearing in *The Metal Industry* for December, a description of the properties and requirements of refractories for metal melting are given. The author is Gerhard Wolff.

PATENTS

CONCENTRATOR Nos. 1,650,725 and 1,650,726, Nov. 29, 1927. Albert H. Stebbins, Los Angeles.

A circular concentrator deck, having a frusto-conical shape and a central opening through which the tailing is discharged. This deck has a material-receiving channel upon it extending around through more than one complete revolution. Also a circular deck with a tailing discharge near its outer periphery, and other features.

CLASSIFIER. No. 1,650,727. Nov. 29, 1927. Albert H. Stebbins, Los Angeles.

An air classifier having several classifying chambers, one over the other, so that the heavier particles pass downwardly through them successively, the materials being disseminated through a group of deflectors mounted in each chamber.

WOOD PRESERVING. No. 1,650,738. Nov. 29, 1927. George Elton Rice, Brooklyn, N. Y., assignor to Conservation Corporation of America.

A process for treating, impregnating and stabilizing wood.

L. O. X. CARTRIDGE. No. 1,650,766. Nov. 29 1927. Chester Mott, Denver, Colo., assignor to Purox Company.

A method of forming a cartridge suitable for use with liquid oxygen for producing an explosion which comprises dehydrating an impure molasses.

REVERBERATORY. No. 1,650,907. Nov. 29, 1927. George W. Prince, Clemenceau, Ariz., assignor for United Verde Extension Mining Company.

In a reverberatory a means at the firing-end wall to supply fettling material to the side walls of the furnace chamber, to protect the sides from the action of the smelting ore and the intense heat.

ROCK DRILL. No. 1,651,199. Nov. 29, 1927. Elmer G. Gartin, Claremont, N. H., assignor to the Sullivan Machinery Company.

An arrangement in a rock drill of independently operable coaxial valves.

The Market Report

Metal Prices Affected by Let-up in Demand

New York, December 14, 1927—Silver has been the firmest of any of the non-ferrous metals in the week ending today though even that market has not been active. Copper and zinc have been extremely quiet. There has been some activity in lead but the total volume of business has declined. Tin has been in reasonably good demand.

Recent metal business has been so good that even with increased consumptive requirements early in the new year not much buying is expected until after the holidays. Whether or not prices will decline in the event of a pronounced let-up in demand during the next three weeks depends in large measure on the attitude taken by sellers.

Daily Prices of Metals

Dec.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
8	13.90@13.925	58.375	58.625	6.50	6.325@6.35	5.80@5.825
9	13.90	58.00	58.50	6.50	6.35@6.375	5.75@5.80
10	13.775@13.925	58.00	58.75	6.50	6.35	5.75@5.80
12	13.775@13.925	58.00	58.50	6.50@6.55	6.30@6.35	5.775
13	13.775@13.925	58.125	58.625	6.50	6.325	5.70@5.725
14	13.775	58.125	58.625	6.50	6.30@6.325	5.70@5.725
	13.856	58.104	58.604	6.504	6.335	5.760

Average prices for calendar week ending Dec. 10, 1927, are: Copper, 13.856; 99 per cent tin, 58.396; Straits, 58.854; N. Y. lead, 6.504; St. Louis lead, 6.350; zinc, 5.819; and silver, 58.229.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary form of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.13c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Dec.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
8	60½	60⅝	66½	270½	264¾	22	22 5/16	26⅜	26⅛
9	60⅛	60¼	66½	267¾	263¼	21 15/16	22 5/16	26⅜	26⅛
12	59¾	59 15/16	66¼	266¼	263⅝	21⅞	22¼	26⅜	26 1/16
13	59½	59 11/16	66¼	266⅞	263⅜	21⅞	22 3/16	26⅛	25 15/16
14	59¼	59⅜	66	266¼	263¼	22 1/16	22 5/16	26 3/16	25 5/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Dec.	Sterling Exchange "Checks"	Silver		Gold London	Dec.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
8	4 87¾	58⅛	26 13/16	84s11½d	12	4 87 15/16	58⅜	26 15/16	84s11½d
9	4 87¾	58⅛	26¾	84s11½d	13	4 87⅞	58⅜	26 15/16	84s11½d
10	4 87⅞	58⅛	26 11/16	84s11½d	14	4 87⅞	58⅛	26⅞	84s11½d
					Avg.		58.208		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths of a cent premium.

Copper at 14c., Delivered

The week ending today has been one of the quietest of the year so far as copper is concerned. Most of the larger producers have held throughout the week at 14⅛c. delivered in the East and 14¼c. in the Middle West, with the few sales that they have made largely confined to the higher freight rate points. Copper appeared on the market as early as Saturday, however, at 14c. delivered in the East, and by today offers at this level had appeared from several directions. Little interest was taken by consumers, however, and it is evident that supplies of prompt copper are adequate. Foreign demand has also been exceedingly quiet, with the export association's price unchanged at 14.50c., c.i.f.

No Interest Taken in Zinc

Prices have gradually weakened from the level of a week ago, the net decline for the week being about one-eighth cent. Sales have again been very small, following the activity of November, and only sharp cuts in price were attractive to buyers. Yesterday and today the market was 5.70c., St. Louis, for December, and 5.725c. for January and February, though several producers refused to quote at these levels. November statistics released by the American Zinc Institute follow, in tons:

Stock, Nov. 1	36,223
Produced	49,217
Shipped	46,120
Stock, Nov. 30	39,320
Shipped from plants for export	1,746
Total retort capacity Nov. 30	131,484
Average number retorts operating	74,218

Production and consumption continued during November at substantially the same rate as in October, the gain in stocks again being about 3,000 tons for the month, thus indicating the advisability of a slight curtailment in producing activity.

Lead Quiet but Firm

Lead buying has been in considerably smaller volume than during the preceding week; but aside from some slight tendency in the Middle West to shade prices in order to attract buyers, quotations are unchanged. The fact that one of the important sellers has sold virtually all of his production through January, and is not seeking business has helped keep down the amount of business. The lead available at 6.325c. or even 6.30c. in the St. Louis market is for the most part for December delivery, the January position being the firmer of the two. One large order was placed on the basis of 6.375c., St. Louis, last Saturday. London has eased slightly but not enough to have appreciable effect on the domestic situation. Antimonial lead has been in rather better demand than usual and a

good premium is to be had on metal of virgin origin. Corroding grades are quoted at the usual premiums of from $2 to $3 per ton. November statistics show an increase in the rate of refined production in the United States and Mexico from 2,420 to 2,600 tons per day. The increase in crude was not so high; and refined stocks in the United States declined from 32,258 to 30,016 tons.

Good Buying of Tin

Consumers have been buying tin in the domestic market more actively than for several weeks, and the price has ruled close to 58.625c. for prompt Straits, with little or no difference for forward positions. Spot metal has declined in London, but three-months' commands a premium of £3, and this strength has helped keep up the domestic market, at the same time encouraging buying by consumers. Indications are that the tinplate industry has better times ahead and this has been a factor in the market.

Silver Quiet and Unchanged

The silver market has remained quiet and steady during the week, the demand being chiefly from London for prompt shipment. India and China have shown some interest in the market, but were not keen bidders at the higher rates.

Mexican Dollars (Old Mexican pesos): Dec. 8th, 9th and 10th, 44¾c.; 12th and 13th, 45c.; 14th, 44¾c.

Foreign Exchange Steady

After reaching a new high, sterling has reacted slightly. Other foreign exchanges are changed only fractionally from a week ago. Closing cable quotations on Tuesday, Dec. 13 were: francs, 3.93¾c.; lire, 5.42½c.; and marks 23.88c. Canadian dollars, $\frac{3}{32}$ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 98 or 99 per cent grade, price of leading interest, 25c.; outside market, 24.30@24.80c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, spot business, range for the week 11½@11¼c. Forward deliveries ⅛ to ¼c. higher.

Cookson's "C" grade, spot, 16⅜c. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, Chinese, 99 per cent Sb_2O_3, 15½c.

BISMUTH—Per lb., New York, in ton lots, $1.85@$2.10. London, 8s.

IRIDIUM—Per oz., $115 for 98@99 per cent sponge and powder. Some activity.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $50@$52. Small lots bring up to $55.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $72. Dealers and refiners quote the trade for refined metal, per oz., cash, $64@$65. Market moderately active.

QUICKSILVER—Per 76-lb. flask, range for week $126@$128, depending on quantity. Market quiet. San Francisco wires $129.50. London, £23; market firm.

RHODIUM—Per oz., $50@$55; London £8@£11½, nominal.

Prices of Cadmium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Dec. 3.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn. c.i.f. North Atlantic ports, minimum 47 per cent Mn; 34@38c. Caucasian, washed, 53@55 per cent, 38.50@40c. Chemical grades unchanged from quotations in the Dec. 3 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.; Wolframite, $10.05@$10.20. Western scheelite, $10.35@$10.50. Market dull.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the Dec. 3 issue.

Zinc and Lead Ores Stronger

Joplin, Mo., Dec. 10, 1927

Blende	Per Ton
High	$42.25
Premium blende, basis 60 per cent zinc	$38.00@39.00
Prime Western, basis 60 per cent zinc	37.00@38.00
Fines and slimes, 60 per cent zinc	34.00@36.00
Average settling price, all zinc	35.08

Galena	
High	$86.20
Basis 80 per cent lead	$85.00@90.00
Average settling price, all lead	84.01

Shipments for the week: Blende, 11,099; lead, 2,826 tons. Value all ores the week, $626,770.

One buyer was in the market early in the week, apparently to cover a shortage, and purchased 2,000 tons on a Prime Western basis of $38 per ton, all other offers during the week resting on last week's price of $37 basis.

Platteville, Wis., Dec. 10, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$39.75

Lead Ore	
Lead, basis 80 per cent lead	$85.00

Shipments for the week: Blende, 918 tons; lead, none. Shipment for the year: Blende, 61,004; lead, 1,965 tons. Shipment for the week to separating plants, 1,851 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the Dec. 3 issue.

Mineral Products

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. Market slack. London, Cornish white, per long ton, £18¼.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Dec. 3 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or c.i.f. port of entry, $100 quoted for first quarter, 1928. Spiegeleisen, 19@21 per cent, $30@$31 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 92@94c. f.o.b. works. Dull.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Dec. 3 issue.

Metal Products

ROLLED COPPER—Sheets, 22¾c.; wire, 15¾@16c. per lb., f.o.b. mill.

LEAD SHEETS—Full rolled 10c. per lb.; clipped, 10¼c.

NICKEL SILVER—29¼c. per lb. for 18 per cent nickel Grade A sheets.

YELLOW (MUNTZ) METAL—Dimension sheets, 19¾c. per lb.; rods 16¾c. per lb.

ZINC SHEETS — 10c. per lb., f.o.b. works.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the Dec. 3 issue.

Steel and Iron Unchanged

Pittsburgh, Dec. 13, 1927

Technically the rate of steel ingot production in November decreased 5.7 per cent from the October rate, but the holiday would account for this, and it may be said that production has been practically uniform since July 1. Substantial increases are to be expected in the first three months of the new year.

Announcement by Bethlehem Steel Co. of bar, shape and plate prices at its Buffalo, Bethlehem, Coatesville and Sparrows Point plants, is likely to set up a separate eastern market to supplant the pseudomarket based on Pittsburgh, thereby contributing stability to both the eastern and the Pittsburgh markets.

Pig Iron—Only an occasional inquiry enlivens the Valley market, which stands at $17.75 for bessemer, $17 for basic, and $17.25@$17.50 for foundry. The Cleveland market has been more active.

Connellsville Coke—Dull. Spot heating, $2.50@$2.75; furnace, $2.75; foundry, $4.00@4.75.

Market and Financial News

Are Greene Cananea Shares Overvalued In the Stock Market?

Many exceedingly optimistic reports concerning the future of the Greene Cananea Consolidated Copper Co., operating copper properties at Cananea, Sonora, Mexico, just a few miles across the border, have been received in New York during the last few months. Not only has the metallurgical practice been greatly improved at this plant, but an enormous new orebody, known as the Colorada has been discovered, which not only will greatly prolong the known life of the mine but will afford a much higher grade of ore for treatment. It is yet too early to state anything definite regarding the extent or the grade of the new orebody, as development has not yet been carried to the point where this is possible. However, in an effort to calculate the present worth of the company's property, the *Wall Street Journal* has made some interesting calculations:

"For some time the company will devote its energies to delimiting the Colorada orebody above the thirteenth level. . . . Assuming 750,000,000 lb. of copper recoverable down to the thirteenth level, or down to 1,000 ft. below the fifth or tunnel level; an average profit of 8c. a pound; mining of the ore at the rate of 70,000,000 lb. of copper a year, making the life of the orebody roughly 11 years, and that a 10 per cent return is demanded with profits reinvested at 4 per cent, the gross recoverable profit in 11 years amounts to $60,000,000, with the present worth about $34,500,000. However, it probably will be another year or longer before the mine is producing at a good rate because of the condition of the copper market and also because it will take some time to commence stoping. This assumed present worth therefore must be further discounted, and becomes at 7 per cent around $31,000,000. As there are 500,000 shares outstanding, this brings the present worth of the shares to roughly $62. Assuming 15-cent copper, the value would become one-eighth greater, and present worth per share $70." In this calculation, the new discovery is estimated to contain about 6,000,000 tons of 6 per cent ore.

Figuring the value of the property on an income-producing basis, the *Journal* proceeds: "While Greene Cananea with present equipment can produce 100,000,000 lb. of copper a year, it probably will be several years before market conditions will permit an output of 70,000,000 lb., and it is far more probable that for the next few years output will not average over 50,000,000 lb.

"With Greene Cananea producing 50,000,000 lb. of copper a year, price of copper 14c., and cost 6c. a pound, the company would show earnings of $4,000,000 a year or $8 a share on the 500,000 shares outstanding. If price average was 15c., annual earnings would be $4,500,000 or $9 a share. It is possible but not probable that annual output for the next few years will average as high as 60,000,000 lb. of copper a year. At that rate of operations annual earnings, with copper 14c. would be $4,800,000, or $9.60 a share, and with price 15c., $5,400,000 a year, or $10.40 a share. If conditions permitted operations at 70,000,000 lb. a year, earnings with copper 14c. a pound would be $5,600,000, or $11 a share a year.

"In trying to arrive at the value of the shares it is far safer to take an average price for copper of 14c. than one of 15c. In figuring the value of these earnings one cannot afford to allow less than 8 per cent for the risk taken, which, with 4½ per cent allowed to amortize the investment in about 15 years, would give to an annual earning of $8 a share a value of $64 a share; to an earning of $9 a value of about $72, and to an earning of $11 a value of $88.

"In addition to this there is also, of course, in this method the value to be placed upon the older properties of the company, together with the cash in the treasury, which with unsold copper amounts to around $3,000,000 or $6 a share."

As the stock is now selling on the New York Stock Exchange in the neighborhood of $120 a share, having risen from a low of $29.25 in the current year, and $9.75 last year, it is evident that speculators are liberal in their estimates of the possibilities at this property.

Anaconda Copper Mining Co., a year or so ago, was reported to own 59,600 shares of Greene Cananea, but it is probable that purchases recently made in the open market have materially increased their holdings.

November Ferromanganese Production Continues at Low Rate

Next to the smallest ferromanganese production for this year was made in November according to the monthly blast furnace returns of the *Iron Age*. The total was 17,851 gross tons as compared with 17,710 tons in October the year's smallest. The largest was 31,844 tons in January. In September it was 20,675 and in August it was 21,279 tons. The production for the first 11 months of this year has been 270,848 tons or 24,620 tons per month. This compares with 26,300 tons per month for all of 1926, so that the production this year is thus far at a smaller rate than last year. The 1925 output was 21,050 tons per month and that of 1924 was 17,090 tons each month.

Spiegeleisen output in November was 6,521 tons. The smallest for this year was 6,037 tons in September. The peak was the 12,907 tons in April. The output to November 1st this year has been 89,552 tons at 8,140 tons per month. This is larger than the rate of output for 1926 which was 6,174 tons per month.

The October ferromanganese output of 17,710 tons is the smallest since November, 1924, when it was 13,448 tons.

Copper Production Declines, but Refined Stocks Climb

Refined copper production in North and South America in November amounted to 118,269 tons, a decrease of 6,658 tons from the month previous, according to figures compiled by the American Bureau of Metal Statistics. The November figures were the smallest for any month since July. Refined exports, however, fell off 6,906 tons in November, the total for the month being 52,013 tons. The domestic shipments amounted to 59,264 tons in November, a drop of 9,355 tons, so that the total shipments for the month were 16,261 tons lower than the total for October.

Refined stocks at the close of November were 90,874 tons, a gain of 6,992 tons. The refined production and shipments for the eleven months of the current year, however, are well balanced, the former amounting to 1,347,583 tons and the latter to 1,342,214 tons. In other words, production exceeded shipments by only 5,369 tons.

Little change in mine production in November is shown. It is argued that as long as mine production is kept down, there is eventually bound to be a decrease in the refined and blister output. The U. S. mines produced 67,813 tons in November, or 1,146 tons less than in October, but the November daily rate was 35 tons greater than in the month previous. The mine production for the eleven months this year was 37,624 tons less than in the corresponding period of 1926.

Production of blister copper in North and South America in November amounted to 111,970 tons, a decrease of 4,352 tons from the October figures. Blister stocks, on the other hand, increased 3,717 tons, these at the close of November amounting to 250,071 tons. The combined increase, therefore, in blister and refined stocks at the close of November was 10,709 tons.

For the past eleven months, the world has been consuming more copper than it has been producing. On December 1, 1926, there was a total world visible supply of 401,519 tons, whereas on December 1, 1927, the world's visible amounted to only 357,220 tons, showing that to meet the ever increasing demand, stocks were reduced to the extent of 44,299 tons.

Mining Stocks—Week Ended December 10, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	53	51	52½	Oc.15, No.21 Q	0.75
Arcadian Consol.	Boston	1⅞	1½	1⅝		
Ariz. Com'l	Boston	6	5¾	6	Jy. 18, Jy. 30	0.25
Calaveras	N. Y. Curb	...	...	1⅝		
Calumet & Arizona	New York	98	90½	96½	De. 3, De. 9 Q	1.50
Calumet & Hecla	Boston	19	18	18½	No. 30, De. 15 Q	0.50
Cerro de Pasco	New York	67½	64⅝	65⅞	Oc.13, No.1 Q	1.00
Chile Copper	New York	38	36½	37½	De. 2, De. 30, Q	0.62½
Con. Coppermines	N. Y. Curb	5	4½	5		
Copper Range	Boston	17¼	16⅛	16⅜	Ap.2, My.2, A	1.00
Crystal Copper	BostonCurb	*40	*30	*32		
East Butte	Boston	2¼	1⅞	2	Dec. 1919	0.50
Granby Consol.	New York	40	38½	40	Jn.15 Jy. 1 Q	1.00
Greene Cananea	New York	123⅜	105	119⅜	Nov., 1920	0.50
Howe Sound	New York	43½	41½	42⅝	Oc.1, Oc.15, Q	1.00
Inspiration Consol.	New York	20½	19½	19⅝	Ma.17, Ap.4, Q	0.25
Iron Cap	Boston Curb	2¼	2⅛	2⅛		
Isle Royale	Boston	13⅜	12½	13¼	Se. 30, Oc. 15, Q	0.50
Kennecott	New York	82½	80	82	De. 2, Ja.3 Q	1.25
Magma Copper	New York	51	48½	50½	Se.30, Oc.15 Q	0.75
Mason Valley	N. Y. Curb	2⅜	1½	1⅞		
Miami Copper	New York	19⅛	18	18⅜	No.1, No.15, Q	0.37½
Mohawk	Boston	50⅜	48½	48⅞	Oc.31, De.1 Q	2.00
Mother Lode Coal	New York	3⅜	2⅛	3⅜	De.16, De.31	0.25
Nevada Consol.	New York	19¾	18¼	19⅜	De.16, De.31 Q	0.37½
New Cornelia	Boston	27¼	25½	27	No.4, No.21 Q	0.50
Noranda	N. Y. Curb	24½	23⅜	24		
North Butte	Boston	1½	1	1⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	1	*78	*99	Sept. 1926	0.03
Old Dominion	Boston	11⅜	11	11¼	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	...	...	126½	De.17, Ja.3 Q	1.50
Quincy	Boston	14¾	11	11⅛	March, 1920	1.00
Ray Consolidated	New York	...	...	15½	Ap.20, Ap. 30	0.25
St. Mary's Min. Ld.	Boston	29	28	28¼	Fe.10, Ma.10	2.00
Seneca Copper	New York	2⅜	2	2		
Shattuck-Denn	Boston Curb	13	11¼	11⅜		
Tenn. C. & C.	New York	10⅜	10⅛	10⅛	No.30, De.15, Q	0.12½
United Verde Ex.	N. Y. Curb	34½	29¼	29⅝	Oc.6, No.1 Q	0.75
Utah Copper	New York	...	...	130	De.16, De.31 Q	1.50
Utah Metal & T.	Boston	1⅞	1⅛	1⅜	Dec., 1917	0.30
Walker Mining	Salt Lake	*54	*49	*53		
NICKEL-COPPER						
Internat. Nickel	New York	73	67½	71⅜	De.16, De.31 Q	0.50
Internat. Nickel pfd.	New York	...	...	108	Oc. 13, No. 1 Q	1.50
LEAD						
Gladstone Mtn.	Spokane	*15⅜	*15	*15	June, 1927	0.005
National Lead	New York	129⅜	122½	125	De. 16, De. 31 Q	1.25
National Lead pfd.	New York	113	112¾	113	Ja.13, Fe. 1 Q	1.50
St. Joseph Lead	New York	41¼	40	40½	De.10, De.20, QX	0.75
ZINC						
Am. Z. L. & S.	New York	7½	6½	7	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	40⅞	39	40⅞	Nov., 1920	1.50
Butte C. & Z.	New York	4½	4	4	De. 9, De. 24	0.50
Butte & Superior	New York	10½	9¼	10⅛	De.16, De.31 Q	0.50
Callahan Zn-Ld.	New York	2	1⅞	1⅞	Dec., 1920	0.50
Consol. Lead&Zinc'A'	St. Louis	12	12	12	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	24½	23⅜	23⅞	No.15, De.1 Q	0.40
Eagle-Picher pfd.	Cincinnati	...	...	117½	Jn.30, Oc.15 Q	1.50
New Jersey Zn.	N. Y. Curb	183⅜	183	183	No. 19, De. 10 X	2.00
United Zinc	N. Y. Curb	...	...	*55		
Yellow Pine	Los Angeles	...	...	*40	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York	1¼	1⅛	1⅛		
Argonaut	Toronto	*36	*32½	*32½		
Barry-Hollinger	Toronto	1.28	1.01	1.25		
Con.W.Dome L.new.	Toronto	*15½	*12	*14		
Cresson Consol. G.	N. Y. Curb	2	1⅞	1⅞	Se. 30, Oc.10 Q	0.10
Dome Mines	New York	13¼	12½	12⅝	Se.30, Oc.20 Q	0.75
Golden Cycle	Colo.Springs	†1.73	†1.71	...	No.30, De.10 Q	0.04
Hollinger Consol.	Toronto	17.25	17.00	17.25	No. 16, De. 2	0.10
Homestake Mining	New York	70	70	70	De.20, De.27 M	0.50
Kirkland Lake	Toronto	2.62	2.38	2.58		
Lake Shore	Toronto	26.95	25.70	26.75	De.1, De.15 QX	0.20
McIntyre-Porcupine	New York	27	25⅜	25⅜	De.1, De.15 Q	0.10
Portland	Colo.Springs	†*25	†*20	...	Ap.6, Ap.15, Q	0.02
Rand Mines	New York	...	...	48⅛	Au.22-29 Am.£h.	1.52
Teck-Hughes	Toronto	10.95	10.00	10.25	Fe.1, X	0.15
Tom Reed	Los Angeles	*30½	*25	*30½	Dec., 1926	0.02
Tough-Oakes	Toronto	*77	*61	*75		
United Eastern	N. Y. Curb	...	...	...	July, 1924	0.05
Vipond Cons.	Toronto	*82½	*69	*72½	Apr.1, Apr.15	0.03
Wright-Hargreaves	Toronto	6.98	6.55	6.60	Oc.17, No.1	0.05
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	12	12	12		
Con. Cortez	N. Y. Curb	*17	*17	*17		
Dolores Esperanza	N. Y. Curb	*58	*50	*50	July, 1923	0.05
Premier Gold	N. Y. Curb	2¾	2⅜	2⅜	De.15, Ja.4	0.08
Tonopah Belmont	N. Y. Curb	1¼	1⅛	1⅛	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	*12	*11	*12	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	2⅛	2	2	Se.20, Oc.21	0.07½
West End Consol.	N. Y. Curb	...	...	*4	Mar., 1923	0.05
Yukon Gold	Boston Curb	*78	*60	*65	June, 1918	0.02
SILVER						
Beaver Consol.	Toronto	2.11	2.02	2.05	May, 1920	0.03
Castle-Trethewey	Toronto	*86	*82	*82		
Coniagas	Toronto	4.75	4.50	4.75	May, 1924	0.12½
Keeley	Toronto	*76	*73	*74	Se.1, Se.15	0.08
Lorrain Trout Lake	Toronto	...	...	*60	July, 1925	0.05
McKinley-Dar.-Sav.	Toronto	*18½	*18	*18½	Oct., 1920	0.03
Mining Corp. Can.	Toronto	4.59	3.80	4.17	Ja. 10, Ja. 25	1.50
Nipissing	N. Y. Curb	6¾	6⅜	6½	De. 30, Ja.20 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	4⅛	3⅝	3⅞	Ma. 25, Ap.4, QX	0.12½
Bingham Mines	Boston	56	55½	56	Se.24, Oc.5 Q	1.00
BunkerHill&Sullivan	N. Y. Curb	136½	135	135½	No. 30, De. 5 X	0.75
Cardiff M. & M.	Salt Lake	*80	*70	*70	Feb. 5, 1927	0.10
Chief Consol.	Salt Lake	2.75	2.60	2.60	Nov., 1926 Q	0.10
Consti'nMng.&Mill'g	Spokane	*30	*16	*30		
Erupcion	Boston Curb	*70	*57	*70	De.17, Ja.2 Q	0.07½
Eureka Lily	Salt Lake	1.17½	1.17½	1.17½		
Federal M. & S.	New York	145	145	145	Jn.25, Jn.29 Spec.	$10
Federal M. & S pfd.	New York	95¼	94¾	95	No. 12 De 15 Q	0.25
Hecla Mining	N. Y. Curb	16⅜	16⅛	16⅜	No.15, De.15 Q	1.75
Highland-Surprise	Spokane	*11⅛	*11	*11½		
Iron King Mining	Salt Lake	*49½	*49	*49		
Keystone Mining	Salt Lake	...	...	*20½	Au. 12, Au. 26	0.07½
Lucky Jim	Spokane	*26⅜	*26	*26¾		
Lucky Tiger-Com.	Kansas City	†7.65	†7.20	...	De.10, De. 20	0.05
Mammoth Mining	Salt Lake	2.05	1.90	1.90	Jn.10, Jn.20 Q	0.05
Marsh Mines	Spokane	1⅜	1⅛	1⅜		
North Lily	Salt Lake	*34½	*35	*35		
Park Utah	New York	7¼	7⅛	7⅞	Se. 15, Oc. 1 Q	0.20
Plutus Mining	Salt Lake	2.50	2.42½	2.50	Oc. 25, No. 10 Q	0.10
San Rafael	San Fran.	*9	*9	*9		
Silver King Coal	Salt Lake	10.50	10.25	10.50	De. 19, Ja.2 X	0.35
Silversmith	Spokane	*25	*23½	*24	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*48	*46	*47		
Sunshine M. Co.	Spokane	1.26	1.20	1.23		
Tamarack-Custer	Spokane	*50	*48	*49½	Sept., 1924	0.25
Tintic Standard	Salt Lake	12.75	12.12½	12.62½	De.20, Ja.3 QX	0.40
Utah-Apex	Boston	5⅜	4½	4⅝	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	54½	51½	53	Se. 2, Oc. 1	1.75
Cleveland-Cliffs Iron	Cleveland	110	100	101½	Oc. 15, Oc. 25 Q	1.00
Colorado Fuel & Iron	New York	79⅞	72⅜	79½	May, 1921	0.75
Gt. North'n Iron Ore	New York	25⅞	23	23⅝	Dec. 6, Dec. 28	0.75
Inland Steel	New York	57⅜	54	55	No. 15, De. 1 Q	0.62½
Replogle Steel	New York	...	...	12½		
Republic I. & S.	New York	60½	58½	58⅝	No. 15, De. 1 Q	1.00
Republic I. & S. pfd.	New York	104⅜	103	104½	De. 14, Ja. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	117	117	117	De. 10, De. 20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York	...	...	110	De. 20, Ja.3 Q	1.75
U. S. Steel	New York	146¼	138	141⅞	No. 30, De. 30 Q	1.75
U. S. Steel, pfd.	New York	138	137⅜	138	Oc.30, No. 29 Q	1.75
Virginia I. C. & C.	New York	....	....	36½	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York	....	....	60½	De. 16, Ja. 3	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York	...	...	27½	Jn. 26, Jn.30	1.45
So. Am. G. & P. New.	N. Y. Curb	2½	2⅛	2⅛		
Alum. Co. of Amer.	N. Y. Curb	138½	130½	133¾		
Alum. Co. of Amer. pf.	N. Y. Curb	106½	104½	106	Se. 15, Oc 1 Q	1.50
Vanadium Corp.	New York	57	53⅜	54⅝	No. 1, No. 15 Q	0.75
Patino M. & E.	New York	24¼	21¾	22	Ap. 27, My. 5	1 sh.
ASBESTOS						
Asbestos Corp.	Montreal	36	32¼	33½	Jan., 1926	1.50
Asbestos Corp. pfd.	Montreal	97	95¾	96	De.31, Ja.16 Q	1.75
SULPHUR						
Freeport, Texas	New York	102½	97½	100⅛	Oc.15, No.1 QX	1.50
Texas Gulf	New York	79⅛	70⅜	77⅛	De. 1, De. 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	42	41⅛	41⅜	No.19, De.1 Q	0.75
Amer. Metal, pfd.	New York	....	....	110	No.19, De.1 Q	1.75
Amer. Sm. & Ref.	New York	177½	170	173	Oc.14, No. 1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	130	130	130	No., Dec. Q	1.75
Consol. M. & S.	Montreal	274½	264	270	Jn. 30, Jy. 15 X	6.25
Newmont Mining	N. Y. Curb	124½	118⅜	118⅜	Se.30, Oc.15 Q	1.00
U. S. Sm. R. & M.	New York	48⅞	44⅛	46	Oc. 6, Oc. 15 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	51	50⅜	51	Oc. 6, Oc. 15 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend

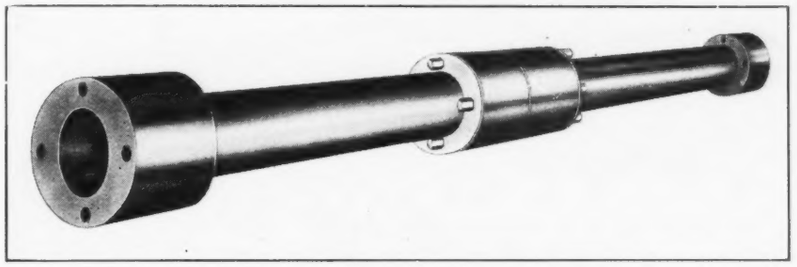
Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED NOV. 29, 1927

Name	High	Low	Last	Date	Amount	Last Div.
Aramayo Mines (25 frs.)	76/—	72/6	75/—	Nov., 1927	5 p.c. (†)	
British Platinum (£1)	—/3	—/3	—/3	Feb., 1925	2½ p.c.	
Burma Corpn. (10 rupees)	13 3	12/9	12/10½	Aug., 1927	6 annas*	
Bwana M'Kubwa (5s)	4/1½	3/6	4/—			
Camp Bird (2s)	3/3	3/—	3/—			
El Oro (£1)	3/6	3/1½	3/6	Nov., 1924	2½ p.c.*	
Esperanza (10s)	—/2	—/2	—/2			
Frontino & Bolivia (£1)	14/—	13/6	13/9	July, 1927	5 p.c	
Mexican Corpn. (£1)	8/3	7/—	8/—			
Mexico Mines of El Oro (£1)	15/—	13/9	15/—	Dec., 1926	3½ p.c.*	
N'Changa Copper Mining	9/9	8/—	9/6			
Oroville Dredging (£1)	6/4½	4 9	5/—	Dec., 1923	3½ p.c.	
Ouro Preto (£1)	2/6	2/3	2/3	May, 1925	2½ p.c.	
Rhodesian Congo Border (£1)	38/9	35/—	36/3			
St. John del Rey (£1)	10/3	9 10½	10 3	May, 1927	3½ p.c.	
San Francisco Mines (10s)	27/10½	26/7½	27/6	July, 1927	15s.	
Santa Gertrudis (£1)	17/3	16/4½	16/6	July, 1927	7½ p.c.	
Selukwe (2s. 6d.)	7/9	6/10½	7/6	April, 1917	6¼ p.c	
S. Amer. Copper (2s.)	2/4½	2/1½	2/3	Nov., 1917	75 p.c	
Tanganyika (£1)	66/3	60/7½	64/4½	Aug., 1927	7½ p.c.	
Union Miniere du Haut-Katanga (Brussels)	10,540	10,350	10,370	July, 1927	182.60 (‡)	

* Free of British income tax. † Swiss francs and plus 15 p. c. bonus. ‡ Belgian frs. and free of taxation.

Industrial Progress



Made of wood fiber, impregnated with pitch-asphalt, this pipe is light, strong and durable

A Mine Pipe That Defies Corrosion

WOOD FIBER as a substitute for iron and steel in making pipe for mine service offers many advantages. It is light—pipe made of it is easily handled underground and on the surface. Wood-fiber pipe, moreover, costs considerably less to ship as freight and can be unloaded more easily because of its lighter weight.

Wood fiber is also a non-conductor. Stray electric currents do not affect it, as they do iron and steel. It is also immune to the corrosive action of acid mine water. Pipe made of it, if properly constructed, should in consequence have a long and useful life. Once laid it should need no attention for years.

Pipe made of wood fiber—sulphate fiber to be exact—is being manufactured by the Brown Company, of Portland, Me. Its appearance is about the same as that of iron. Its surface is smooth and very hard. This pipe is impregnated with pitch-asphalt by being boiled in it under pressure, in vats, for six hours. It is being marketed under the name of "Bermico" pipe and may be had in diameters from 2 to 6 in. and in lengths from 48 to 93 in.

This wood-fiber pipe is strong enough, the makers claim, to withstand any pressure to which mine pipe is ever subjected. It has no staves to give way and does not swell or shrink. It can be used in vertical as well as horizontal lines.

Connecting the Pipe

How is this pipe connected? This is accomplished as follows: The end of each section is a collar, about 1½ in. larger in diameter than the rest of the pipe. This collar is drilled lengthwise with four, six, or eight holes, according to the pipe diameter. Through these holes are passed threaded rods of cold-rolled metal, and these in turn are capped at each end with capnuts of Ascaloy metal, which, like the pipe itself, is impervious to acid and electrolysis. Between the capnut and the back of the collared end is interposed a collar washer, also of Ascaloy. This washer is made in two sections so it can be placed around the pipe. Its function is to protect the pipe from injury by tightening up the capnuts. This tightening process compresses the fiber just enough to seal effectively the holes through which the bolts pass, making a perfect protection for the bolts themselves, which are thus tightly sealed inside the collar drillings. The ends of the pipe are butted smooth by a hot ironing process and the inner and outer surfaces are finished smooth.

Laying pipe of this sort is said to be comparatively easy. It weighs only a quarter of what iron would weigh, and so can easily be jockeyed into position. No tools are required other than the ordinary wrench. Skill is unnecessary.

The pipe may be stored outdoors indefinitely. The collared ends, being of larger diameter, make the only frictional contact in such storage, and these are strongly wrapped at the factory to prevent even that.

Wire Rope Business Merged

The Hazard Wire Rope Company, of Wilkes-Barre, Pa., has acquired the wire and wire rope division of the Waterbury Company of Brooklyn. This brings together the combined experience, products, and resources of two pioneer companies manufacturing wire and wire rope.

Two New Diamond Drills

THE accompanying cuts show two types of diamond drills that have been placed upon the market by the Sullivan Machinery Company, of Chicago. Fig. 1, which shows the "Baby Turbinair," is the latest development in a light, portable diamond-core drill for shallow prospecting underground. It is compact and sturdy in construction and can develop remarkable power and performance, according to the makers.

This machine is similar in most respects to the standard Turbinair drill except that the hoisting mechanism has been left off, permitting an important reduction in weight. It has the same capacity as the heavier machine for rotating and feeding the rods, but is rated at a capacity in depth of only 150 ft., which is about the limit of the amount of rods which can be handled without a hoist. This capacity, however, is ample for much underground prospecting. Modern practice in motor design has been observed in working out details of this machine.

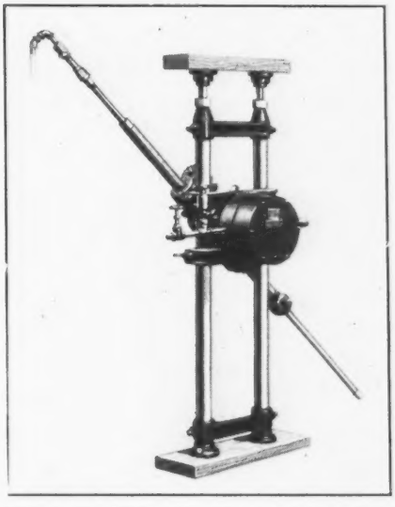


Fig. 1—A light portable diamond drill for shallow work underground

The drill will handle "E" rods and fittings, which drill a hole 1 $\frac{9}{16}$ in. in

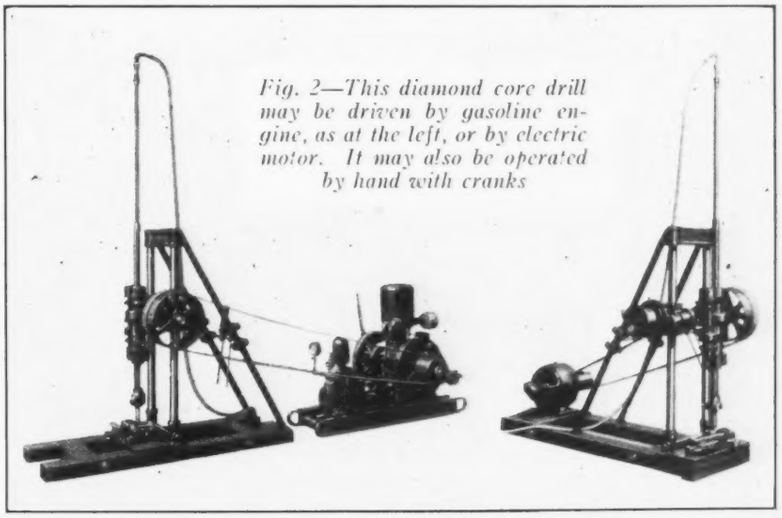


Fig. 2—This diamond core drill may be driven by gasoline engine, as at the left, or by electric motor. It may also be operated by hand with cranks

diameter, and recover a $1\frac{5}{8}$-in. core. If desired, a size "A" core barrel may be used on the "E" rods. This barrel drills a hole $1\frac{1}{8}$ in. in diameter and recovers a $\frac{1}{8}$-in. core. The drill is mounted on two columns, and extension jackscrews permit adjusting the mounting to any desired height of roof. Holes can be bored at any angle desired. The drill can be readily knocked down for moving. Also, the entire outfit can be disassembled in fifteen minutes.

The engine or motor used is of a design new in diamond-drill practice. It has no reciprocating parts, is almost noiseless, and runs without vibration and practically without repair or replacement of working parts.

Fig. 2 shows two views of the "Bravo-300" diamond-core drill, with gasoline engine and electric motor drive respectively. This machine is intended for hand drive as well. It is said that it will do any work performed by the old Bravo, but with greater speed and convenience, and at lower cost. The drilling mechanism or swivel head recently designed for the Turbinair has proved so satisfactory that it was decided to use it also on this machine, the makers say. A growing demand for electric motor drive in underground prospecting has made changes in pulley speeds desirable also, which in turn requires a change in hoist or cathead. The result is practically a new drill, better adapted to electric motor use, but equally well suited to belt drive from a gasoline engine. The rotation speed of the chuck is now the same as the pulley speed. This drill is adapted for boring shallow prospect holes 50 to 200 ft. in depth at low cost. This naturally includes work in remote regions.

How a Cone Crusher Worked in a Pachuca Mill

In view of the inquiries received by the Negociacion Minera de San Rafael y Anexas regarding the results obtained with the Symons cone crusher in its mill at Pachuca, the following data are contributed by the Director General of the company, Fred. MacCoy:

The ore crushed is a mixture of quartz and silicified andesite, as is usual at Pachuca. The discharge of a No. 5 McCully crusher furnishes the feed for the cone machine, the maximum size of the pieces being $3\frac{1}{2}$ in. The capacity of the cone crusher is limited by that of the McCully, so that the average output is 70 metric tons per hour or 77 U. S. short tons. The average power consumed is 48 hp., although under heavy load this has risen at times to 66 hp.

The nature of the product is shown by the following screen analysis, which is the average of several:

All through 1 in. mesh	
On $\frac{1}{2}$ in. mesh	35.8%
On 4 mesh	30.7%
On 6 mesh	10.4%
On 10 mesh	7.3%
On 20 mesh	6.2%
Through 20 mesh	9.6%
	100.0%

This cone crusher replaced three 9x15-in. Blake-type machines, which were limited to a discharge of $1\frac{1}{2}$ in., the product more frequently being 2 in. Installation of the new machine raised the average mill capacity from 570 metric tons to 705 per day.

Total cost of crushing and fine grinding, including conveying and storage in bins, was as follows:

	Mexican pesos per metric ton			
	Labor	Material	Power	Total
Before installation..	0.69	0.61	0.49	1.79
After installation..	0.54	0.59	0.39	1.52

This is not offered as an example of good work, because much work is still to be done on the fine grinding equipment to bring it up to efficiency.

The mechanical principle of the cone crusher is that of a gyratory in which the crusher head has been widened out into the form of a flat cone, which gyrates 240 times per minute. The slope is such that the broken ore drops through by gravity, yet travels slowly enough to receive innumerable blows, thereby insuring a thorough and uniform crushing.

The machine is designed to take care of tramp iron, so that if a hammer head gets into it, the springs give sufficiently to avoid breaking the mechanism. However, tramp iron can do the crusher no good, so the ore is fed by a feeder belt protected by a Dings magnetic pulley, as well as a suspended Ohio lifting magnet. Both of these magnets are operated from the same switchboard as the feeder belt. This belt is not started until the pilot light shows that the magnets are carrying current. On one occasion the operator failed to attend properly to the sequence of starting and let the belt feed a hammer head into the cone crusher, but no harm followed, as the springs worked as expected.

More Drill Bulletins

In addition to the rock drill bulletins, issued by the Ingersoll-Rand Company, that were mentioned in last week's issue, a second group of four bulletins, from the same company, have also made their appearance, attractively bound in a folder. These are as follows:

No. 4063, on drifters, and containing 32 pages; No. 3136, on "Jackhamers," 32 pages; No. 4436, on "Stopehamers"; and No. 4159, on "Little Tugger" hoists, 32 pages.

The Sullivan Machinery Company has also issued two new bulletins; one of these is No. 81-Q on "Rotator" rock drills, of the "L-5" medium model and the "L-3" heavy model. These hand-held hammer drills are intended for down-hole drilling in which the conditions are too severe for ordinary rotators. The other is No. 81-O, covering the auger rotator, Class H-8.

Outdoor Switchhouse Made Safer

Small power and lighting customers of electric companies are continually demanding greater reliability and better continuity of service. Since the revenue from such customers is comparatively small, the equipment to accomplish the desired results must be relatively inexpensive. Many of these smaller power consumers are remotely located and the installation of an outdoor substation would, from the standpoint of cost, be out of the question. In an effort to cope with the above situation, many new developments and perfections of design have been accomplished in outdoor weatherproof switchhouses as these seem to be the most inexpensive means of furnishing the desired results.

An improved housing for outdoor switchboards

The Westinghouse company has made several important and desirable changes in the design of its outdoor switchhouses, the most prominent of which is the reduction in height which gives a more compact single unit and also allows ready mounting under existing structures and busses. Another desirable feature is the complete isolation of the front equipment from that in the rear of the houses without decreasing accessibility. This assures a unit which is entirely dead front, neat in appearance, and rigid in construction. The meters and relays are now mounted on steel instead of slate panels which also provide additional bracing to the houses as well as eliminating the possibility of panel breakage. The circuit breaker control relay is mounted in a glass case, thus removing all danger of contact with live parts in the front of the house in case of carelessness.